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(54) Title: WIRELESS COMMUNICATIONS GATEWAY FOR A HOME OR SMALL OFFICE

(57) Abstract: Systems for connectin telecommunications infrastrustures lines to telephones, handsets, computers, telecopy machines and other end user interfaces or consumer electronis devices in a residence or business. Systems according to the present invention inclue network control units which form the center of a star topology and which communicate via RF link with wireless access units and handsets. Wireless access units feature and interface, such as, for example, a standard telephone jack, for accommodating a telephone, a fax machine, a computer modem or other device. Numerous wireless applications are available through this system, including wireless home entry and security monitoring, internet connectivity, IP telephony, interfacing with PCS devices, and use with optical network units of telecommunications service providers. Such networks can be entirely mobile, connected to outside telecommunications networks via air interfaces such as cellular or PCS telephony interfaces. Wireless access units also allow vehicles to form part of such systems, so that various forms of information may be communicated between vehicles and residences or businesses. Control functionality for such systems can include intelligence of the sort found in telecommunications network elements and devices for providing advanced services to the user. Additional functionality can be included for supporting internet sessions.

WIRELESS COMMUNICATIONS GATEWAY FOR A HOME OR SMALL OFFICE

This document is a continuation-in-part of U.S.S.N. 09/292264 filed April 15, 1999 which is entitled, "Wireless Communications Gateway for A Home or Small Office," which is a continuation-in-part of U.S.S.N. 09/229,848, filed January 12, 1999, entitled "Wireless Communications Gateway For A Small Home Or Office," Penzias, Snelling, McIntosh, Tucker, and other inventors, which is a continuation-in-part of U.S.S.N. 09/083,726, filed May 22, 1998, entitled "Communications Web for PSTN Subscribers", Snelling, McIntosh and Tucker, inventors, which is a continuation-in-part of U.S. Patent No. 6,058,104 issued May 2, 2000, entitled "Communications Web for PSTN Subscribers," Snelling, McIntosh and Tucker, inventors, which is in turn a continuation-in part of U.S. Patent No. 5,805,582 issued September 8, 1998 entitled "Home Personal Communications System," Snelling, McIntosh and Tucker, inventors, which is in turn a continuation of U.S. Patent No. 5,555,258 issued September 10, 1996 having the same inventors, all of which are incorporated into this document as if fully set forth herein.

FIELD OF THE INVENTION

The present invention is related to a system for interconnecting several devices and, more particularly, to a system for wirelessly interconnecting telephony devices and computers.

BACKGROUND OF THE INVENTION

Demand for access to voice and data communications on the public switched telephone network ("PSTN") is growing exponentially. Not only is the subscriber base expanding logarithmically, but even more significantly, individual subscribers are beginning to require more than one number and frequently multiple numbers. In addition to cellular telephones, pagers, and other mobile devices, home-based connectivity is a significant factor in this exponential growth of the PSTN. Subscribers have begun in recent times and

in significant volume, to require second and third lines as a matter of course, such as for Global Information Infrastructure (so-called "Internet") connectivity and data communications and for childrens' lines.

Although it is conventional for a residence to contain standard telephony devices in various rooms supported by one line and perhaps a computer supported by another, the days of standard analog "plain old telephone service" or "POTS" are waning as demand for bandwidth to support graphics, interactive technology and the so-called "push technology" on computer devices grows. In 1995, for instance, the Regional Bell Operating Companies ("RBOC's") began transporting more data than voice communications. Accordingly, not only are subscribers employing more lines; the nature of the connection is also changing. The rate of change will only increase over time.

The increased demand for residential subscriber lines, and the ever changing nature of those lines as new standards are developed in order to accommodate new and different services, occur in the face of a major residential constriction: wiring of the residence. Standards such as DSL aim to minimize that problem by delivering multiple channels on a single line and splitting analog and digital channels at the customer demarcation point in a manner that allows digital signals to be delivered in the vicinity of the computer. That paradigm is compromised as, inevitably, subscribers require computers and other connected electronic devices throughout the residence. These devices will not only resemble computers or televisions in nature, they may be any electronic device one wishes to access remotely. The anticipated 128-bit Internet protocol address format will, it is estimated, accommodate every lightbulb in the world.

Presently, however, most residences feature only single twisted pair wiring in the walls and in many cases, a cable television connection. Other more technologically current residences feature a satellite television connection, as well as one or more wireless interfaces by virtue of wireless telephones and personal digital assistants in the possession of residents. Rewiring for additional lines throughout the house, whether via current

twisted pair or perhaps coax standard, is trouble and expense enough, and a great disincentive which constricts demand for increased residential bandwidth. As time passes and the rate of technology change increases, however, subscribers could find themselves needing to rewire every several years in order to accommodate changing standards and increasing bandwidth.

These factors create a need for connectivity in the residence between the PSTN (including for purposes of this document not only conventional circuit-switched telephony networks, but also packet switched data networks, or any other form of network providing access to any set of subscribers or customers, whether provided by twisted pair wireline connection, via fiberoptic or coaxial or other cable connection, or via satellite or terrestrial wireless connection) customer demarcation point and telephones, computers, fax machines, and any other device which may be connected to the PSTN or feature an IP address. Such connectivity must suffice not only for today; it must alleviate the need to rewire the residence in order to accommodate new changes, it must accommodate new devices, formats, protocols and standards, whether analog or digital, and it must be flexible and modular in design in order to accommodate a wide-ranging set of needs and preferences among the subscriber base. As more peripherals enter the home, the interconnectivity of these peripherals becomes more important. Put another way, a flow of consumer electronics, computer equipment, entertainment devices and other electronic equipment continues to reach the market, consonant with a flow of new and diverse content being offered on various electronic media, via various transport media including those originating from telephone companies, cable television companies, electric power companies, wireless communications providers, satellite communications / content providers and others. All of these present challenges to existing wiring in the home, and are otherwise appropriate to deliver and manage using a home network which eliminates the need for wiring such as fiber, coaxial or twisted pair, and which allows the user to manage and control delivery of content and communications to various devices whatever they may be, now or in the

future. The use of such a network offers increasing advantages as addressability of particular devices assumes increased prominence and relevance in how content and communications are delivered and employed by users. In short, there is a need for a system which can take any sort of content or communication, whether or not addressed, address that content or communication to a particular device or devices as desired by a user of the system, and place the content or communication on a wireless link for delivery to the device bearing the address for use by the user.

Optical Network Units ("ONUs") are small, low-cost units that minimize the distance between a PSTN subscriber and a central office ("CO") of a local service provider. An ONU typically serves 12 to 20 residences and connects back to the CO via a high-speed optical link. The ONU provides an interface between the local service provider's optical fiber network and twisted-pair, copper subscriber loops. The ONU includes the multiplexers, demultiplexers, concentrators, POTS and ISDN line cards, DSL drivers and diplexers, and the other circuitry necessary to provide numerous digital and analog subscriber services. A built-in, uninterruptible power supply provides the power. Often, a ring topology is used to provide redundancy. The ring topology allows service to continue despite catastrophic interruptions to one point on the ring.

A physical connection is required between the ONU and the subscriber's home since copper line is being used for such a connection. Thus, the addition and/or modification of lines requires that new lines be buried in the ground. Alternatively, existing lines may be dug out of the ground. In either case, the burying or digging of lines into or out of the ground can become very expensive and troublesome for a telecommunications company. Moreover, the modification of lines can be dangerous to the repairperson.

As computer telephony devices become more ubiquitous, giving impetus for intelligence to be distributed more broadly through and beyond the PSTN, it becomes desirable to distribute intelligence to user equipment such as systems as disclosed in this document. For example, various billing tasks, call routing and handling tasks, user services, (provision of which often

requires interconnectivity with various network elements in the PSTN) and other functionality can be transferred downstream into such equipment or systems. Systems according to the present invention unlock the potential to place this intelligence closer to the user level thereby more efficiently to provide user services and track them, as well as to promote the telecommunications network which becomes more efficient because it requires less centralized command and control.

From another standpoint, many telecommunications and internet users spend many waking hours in their vehicles. Accordingly, the vehicle is a natural access site for systems according to the present invention. Internet and telecommunications users find it desirable to be connected or updated to various sorts of data and services while in their vehicles. From a first perspective, it would be convenient to monitor residence alarm systems from the vehicle, and vehicle alarm systems from the residence. Users will also find it desirable to have access to their current calendar and address lists, e-mail access, web content such as weather conditions and maps for directions, and information from the home alarm system such as presence of fire or an intruder. Similarly, users will find it desirable to perform various functions such as starting their automobile remotely in cold conditions, paying toll authorities, scheduling maintenance visits and other tasks based on intelligence gained by systems according to the present invention which have access to vehicle information and systems.

Given the ubiquity of internet connectivity, it is desirable for each of the devices on systems according to the present invention to be independently addressable via the system controller, whether such address is for use on the internet or otherwise. Not only computers, but also telephones and handsets are addressable for internet sessions and thus require such addressability in accordance with systems of the present invention. Furthermore, it is desirable for systems of the present invention to contain functionality that enables enhanced and easier connection to remote internet destinations, and to make and execute automatically routing and switching decisions to place calls via the internet or via circuit switched networks.

SUMMARY OF THE INVENTION

Systems according to the present invention feature a Network Control Unit or Web Control Unit ("NCU") which interfaces to any desired number of PSTN lines. Where the lines are analog, a Network Interface digitizes the signals, transmits them to a digital signal processor, and otherwise renders them compatible for delivery to an ASIC in the NCU. Signals from the signal processor are delivered to a Conference Accessory Block ("CAB") module which may be programmed in the residence or remotely to connect signals from each line to any predetermined combination of telephony, computer, or other electronic devices in the residence. The CAB is coupled to a slot machine in the ASIC that assembles data into data units for transmission by a radio multiplex engine. The radio multiplex engine multiplexes the signals for bandwidth efficiency and other purposes, and delivers them to an NCU Radio Transceiver for delivery via RF link, which may also be multiplexed if desired, throughout the residence.

At the other end of the RF link, the system features handsets and/or Wireless Access Units or "wireless jacks." The handsets include an ASIC that is preferably similar or identical to the ASIC used in the Network Control Unit, although a simpler ASIC may be used. The ASIC in the handsets interfaces the radio transceiver to analog / digital conversion circuits such as so-called "codec's" and control circuitry with a combination of, for instance, microphone and earphone for voice communications, and perhaps a jack for data communications. The Wireless Access Unit contains circuitry similar to the handset in analog environments, plus additional circuitry for delivery of the signal to a standard interface such as an RJ-11 jack. Such Wireless Access Units can be made available, according to the present invention, to accommodate any physical and electrical interface standard, such as Wireless Access Units for ISDN interfaces and any other desired digital services.

Accordingly, the PSTN lines may terminate in the residence at a Network Control Unit which may be physically small and innocuous in

appearance, perhaps mounted on a wall and, if desired, coupled to a nearby electrical outlet and to a personal computer or other interface if the user desires control other than by interfaces on the Network Control Unit itself. The unit may feature a stub antenna or other desired antenna. Throughout the residence, any device desired to connect to the PSTN can contain its own Wireless Access Unit which may be battery powered and connect to the NCU via RF link.

In sum, and more thematically, the present invention provides wireless networks which can accommodate various forms of communications devices or systems, entertainment devices or systems, computing devices or systems, utility devices or systems, and any other electronic device or system a user wishes to place in access to content or communications sources or resources external to the wireless network. The networks may be programmed by the user to deliver any form of content or communications to any desired device or system, each such device or system being assigned one or more addresses by the networks. As merely one example, the user may program one or more Network Control Units on the network, using a graphical user interface that appears on a handset already on the network, to match an incoming port or line on the Network Control Unit with a particular computer or telephone in a certain room. When content or communications reach a port on the Network Control Unit, it is placed in digital form if not already, assigned the user-allocated address or addresses of the relevant device or system, and placed on a wireless link for reception and rendering by the relevant device or system. The relevant device or system has or is coupled, physically or via air interface, to functionality that senses content or communications addressed to it, transforms the content or communication into form usable by the device or system, and renders it for use by the user. Addition of new circuitry or software to that already contained in the Network Control Unit, to allow the network to accommodate and deliver any form of content or communications transport or other protocol, can be done in a modular way, and with ease.

The present invention accordingly makes possible wireless, efficient, flexible and modular connectivity between any desired device and the PSTN

within the residence. The Network Control Unit itself may be modular in design to accommodate various circuit boards or additional software in flash memory or other memory for various changing and evolving standards and protocols. New Wireless Access Units may be purchased for whatever particular devices a particular subscriber desires, and he or she may update the system with new circuit boards, additional software and new Wireless Access Units and perhaps new handsets as time passes, new devices and services evolve, and standards change. Such updates may occur online by dialing a customer services center or automatically at predetermined times of the day. For instance, upgrades may occur via Internet in an automatically initiated periodic process or otherwise. The Network Control Unit can initiate a session with a server for such upgrading, or the server can initiate a session with the Network Control Unit. Such upgrades can be performed automatically at predetermined or periodic time intervals or initiated by users.

Numerous possible wireless applications may be used in the present invention. For example, home entry and security systems may be coupled to the wireless access units to allow monitoring of visitors or potential intruders via the handsets. Internet connectivity would allow the wireless downloading of data to wireless music and video playback devices. IP telephony protocols would allow wireless tele / videoconferencing between two subscribers. Broader applications include the use of PCS devices for wireless local access to the PSTN to allow long-distance telecommunications companies to avoid local charges. In addition, the system of the present invention may be used with Optical Network Units to allow wireless fiber-to-the-curb access.

Network control units according to the present invention are adapted to contain appropriate intelligence and functionality which enables them to perform many of the functions traditionally performed by telecommunications switches. These functions include call routing, reporting, billing and management services, and provisioning and tracking of services such as call forwarding, caller ID and other services which require interconnectivity with intelligent network elements in the telecommunications network. In this sense, systems according to the present invention enable better and more

efficient provisioning and tracking of services to users and promote a more efficient and effective telecommunications network with reduced requirements for centralized intelligence, command and control.

According to another aspect of the invention, automobiles and other vehicles are provided with access units which may be coupled to corresponding computers or to the vehicle computer already extant. The vehicle access unit enables vehicle operators to be connected or updated to telecommunications, internet, home status and other information. Thus, drivers who spend precious time behind the wheel may, via the present invention, access voicemail, e-mail, web content such as weather conditions and maps, home alarm or other status information, calendars and address information. This information may be provided by a handset, speaker, visual display, radio, visual indicators, or control directly to alter vehicle systems such as the starter/ignition, other components of the engine, brakes, steering or other components or systems of the vehicle. The residential system may access vehicle systems in order to perform tasks such as remote starting of the vehicle, automatic payment to toll authorities, automatic notification and scheduling of maintenance, and other vehicle related tasks. Alarms and other status information from the residence may be monitored in the vehicle, and alarms and other status information from the vehicle may be monitored in the home.

A further aspect of the invention permits handsets, computers, telephones and any other devices forming part of systems according to the present invention to be independently internet addressable while retaining a private address. According to one architecture, each device has a private address, and the network controller according to the present invention includes functionality which performs translation of that private address to a public address, both upstream and downstream.

According to another aspect of the invention, enhanced internet connectivity is provided by employing enhanced storage and processing of internet addresses. Such storage and processing capacity, which is referred to as "server" capacity, can form part of the circuitry of the network control

unit or can subsist as stand-alone functionality connected to the network control unit, or it can be located outside systems according to the present invention. As an example of benefits associated with such storage and processing, the system can contain an internet protocol address server with a list of active (and perhaps non-active) users and their IP addresses (current if the IP address is dynamically assigned). The IP server may be maintained in the system or remotely. When a user dials a destination that has an address or number not on the system, the system can contact the server for the IP address of the destination. If the destination is active and has an IP address, the system will proceed to connect to the destination via an internet connection. If the destination does not have an IP address active, or is inactive, or is refusing connections, then the system will connect to the destination over standard circuit switched paths or telephone lines. The server can maintain currency with the current IP address and status of the destinations according to several possible methods. First, the server can periodically query the destinations to obtain IP addresses and their status. Second, the destination upon power-up can send relevant IP address information to the server. Third, the destination, at regularly scheduled time intervals, can query the IP server to provide up-to-date information. The server may also contain up-to-date information to permit the caller to achieve the lowest possible cost calls to various destinations. Rate information can be provided by the user or by a service. Users may also enter their preferences. For example, a user may select to never make phone calls using the internet because the user objects to the sound quality or other features of internet protocol telephony.

Given the greater emphasis on mobility in telecommunications functionality, it becomes of increasing importance to provide mobile solutions to users. In accordance with that notion, systems according to the present invention may be adapted for mobility simply by connecting to a mobile power supply and to a telecommunications network such as the PSTN via an air interface. The system so mobilized allows multiple users to connect with each other in the field or wherever desired, and to telecommunications

networks such as the PSTN via interfaces such as cellphone and PCS telephony interfaces. Examples of evolving standards or protocols for wireless interfaces to the PSTN or networks more generally (including without limitation local area networks and wireless local area networks) include in addition to cellular and PCS system standards such as Wireless Access Protocol, the Bluetooth Special Interest Group's Bluetooth Standard for air interfaces and the IEEE 802.11 Wireless Standard and the HomeRF Shared Wireless Access Protocol (SWAP) for linking devices in small office or home networks. Air interfaces according to such standards, which address multiple approaches for transporting information over wireless links, can all be used in accordance with the present invention for providing additional access to public switched telephone or data networks, and, for allowing additional wireless connectivity between or among devices in networks according to the present invention, and for implementing networks which can interoperate with networks according to the present invention.

It is an object of the present invention to provide business and residential wireless connectivity between telecommunications networks such as the PSTN and computers, handsets, and other devices which eliminates the need to rewire businesses and residences in order to accommodate new standards and services.

It is an additional object of the present invention to provide RF based connectivity between any number of telecommunication network (such as PSTN) lines and any number of now existing or future electronic devices, in a modular and flexible, and where desired, mobile manner.

It is an additional object of the present invention to provide a flexible, modular, system which provides connectivity between telecommunications networks such as the PSTN and any desired electronic devices a subscriber wishes to connect, via RF link, including, for example, via the air interface, cellular, PCS, and wireless local area network standards mentioned above..

It is yet another object of the present invention to provide for easier coupling of signals from optical network units to equipment within the home.

It is an additional object of the present invention to provide user equipment which contains intelligence and other functionality previously more centralized in the telecommunications network, in order more efficiently and effectively to deliver services to the user and to track them.

It is an additional object of the present invention to distribute intelligence and other functionality downstream from telecommunications networks to user equipment in order to reduce centralized intelligence, command and control requirements upon telecommunications systems.

It is an additional object of the present invention to provide various services and information to vehicle occupants by making the vehicle part of systems according to the present invention.

It is a further object of the present invention to provide vehicle control and vehicle occupant information, and to perform vehicle-related tasks, via systems according to the present invention.

It is a further object of the present invention to provide capacity for privately addressing devices forming part of systems of the present invention, while not interfering with internet sessions in which they are involved.

It is a further object of the present invention to provide internet addressability for devices forming part of systems according to the present invention in a manner that does not interfere with their connectivity to multiple communications and network lines and paths via such systems.

It is an additional object of the present invention to provide systems according to the present invention with functionality which enhances internet telephony using current internet address data which may be invoked and/or employed automatically.

It is a further object of the present invention to provide systems which allow automatic routing of calls via the internet for cost savings, as determined by rules selected by the user.

Other objects, features and advantages of the present invention will become apparent with respect to the remainder of this document.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic view of a residence which features one embodiment of a system according to the present invention.

Figure 2 is a greatly simplified, representation of a time division frame having slots in accordance with one embodiment of the present invention.

Figure 3A is a high level functional block diagram of an ASIC for use in a Network Control Unit, handset, or Wireless Access Unit according to one embodiment of the present invention.

Figure 3B is a block diagram, at a lower level than Figure 3A, of a Network Control Unit interface according to one embodiment of the present invention in which four coder / decoder or "codec's" are employed in connection with four analog POTS lines.

Figure 3C is a functional block diagram of a switch used in a Conference Accessory Block.

Figure 4 is a functional block diagram of one embodiment of a handset according to the present invention.

Figure 5 is a functional block diagram of one embodiment of an analog Wireless Access Unit according to the present invention.

Figure 6 is a functional block diagram of one embodiment of a digital Wireless Access Unit according to the present invention.

Figure 7 is a high level, greatly simplified block diagram of a slot protocol data unit and a forward error correction protocol data unit according to an embodiment of the present invention.

Figure 8A is a block diagram of the transmission side of one embodiment of a slot machine according to the present invention.

Figure 8B is a block diagram of the receive side of one embodiment of a slot machine according to the present invention.

Figure 9 is a block diagram of one embodiment of a soft decision decoder according to the present invention.

Figure 10 is a high level functional block diagram of the transformation of a protocol data unit to a network or audio payload format.

Figure 11A is a simplified flow diagram illustrating one configuration sequence of the Network Control Unit of Figure 3.

Figure 11B is a table showing configuration of the Network Control Unit of Figure 3 resulting from the configuration sequence shown in Figure 11A.

Figures 12 - 12 E are block diagrams showing operation of a communications web according to the present invention according to Example 1 discussed below.

Figures 13 - 13E are block diagrams showing operation of another communications web according to the present invention according to Example 2 discussed below.

Figure 14 is a top plan of a location using one embodiment of the system of the present invention with a home entry system.

Figure 15 is a top plan of a location using one embodiment of the system of this invention with a security system.

Figure 16 is a block diagram of one embodiment of a music-on-demand system according to the present invention.

Figure 17A is a block diagram of one embodiment of a wireless videoconferencing device used with the system of the present invention.

Figure 17B is a block diagram of one embodiment of the system of the present invention used for conducting IP telephony.

Figure 18 is a block diagram of one embodiment of a Personal Communications System used with the system of the present invention.

Figure 19 is a block diagram of one embodiment of a speakerphone/charger for systems of the present invention.

Figure 20 is a block diagram of one embodiment of an optical network unit used with systems of the present invention.

Figure 21 is a schematic showing a vehicle in communication with systems according to the present invention.

Figure 22 is a schematic showing one version of a vehicle system according to Figure 21.

Figure 23 is a schematic showing a second version of a vehicle system according to Figure 21.

Figure 24 is a schematic showing a third version of a vehicle system according to Figure 21.

Figure 25 is a schematic view showing, at a higher level, a vehicle in communication with a residential system according to the present invention.

Figure 26 is a schematic view showing, at another high level, a vehicle in communication with a residential system according to the present invention linked to an alarm system.

Figure 27 is a schematic view showing, at a high level, a form of network address translation functionality according to the present invention for providing private addressability of devices forming part of the system.

Figure 28 is a schematic view showing one embodiment of network address translation according to the present invention.

Figure 29 is a schematic view of a mobile network according to the present invention.

Figure 30 is a schematic view of a network according to an embodiment of the present invention in which a wireless device is linked via a physical connection to the network control unit, in order to provide one form of wireless public network access to the network.

Figure 31 is a schematic view of a network according to an embodiment of the present invention in which a wireless device is linked via a wireless connection or air interface to the network control unit, in order to provide one form of wireless public network access.

Figure 32 is a schematic view of a network according to an embodiment of the present invention in which a wireless device is linked via a physical connection to a wireless access unit, in order to provide one form of wireless public network access to the network, and/or connectivity over the network to the device.

Figure 33 is a schematic view of a network according to an embodiment of the present invention in which a wireless device is linked via a wireless connection or air interface to a wireless access unit, in order to provide one form of wireless public network access to the network, and/or connectivity over the network to the device.

Figure 34 is a schematic view of a network according to an embodiment of the present invention in which a non-HWN network or system, which may be wireless, is linked via a wireless connection or air interface to the network control unit, in order to provide one form of public network access and/or connectivity to the non-HWN network.

Figure 35 is a schematic view of a network according to an embodiment of the present invention in which a non-HWN network or system, which may be wireless, is linked via a wireless connection or air interface to a wireless access unit, in order to provide one form of public network access and/or connectivity to the non-HWN network.

Figure 36 is a schematic view of a network according to an embodiment of the present invention in which a non-HWN network or system, which may be wireless, is linked via a physical connection to a network control unit, in order to provide one form of public network access and/or connectivity to the non-HWN network.

Figure 37 is a schematic view of a network according to an embodiment of the present invention in which a non-HWN network or system, which may be wireless, is linked via a physical connection to a wireless access unit, in order to provide one form of public network access and/or connectivity to the non-HWN network.

Figures 38A and 38B are schematic functional block diagrams which show two exemplary forms of television programming content delivery processes according to the present invention.

DETAILED DESCRIPTION

Figure 1 is a schematic hypothetical floor plan for a residence or business containing a communications web according to the present invention. The floor plan shows a Network Control Unit or "NCU" 100 which terminates four central office POTS lines designated "CO1" through "CO4." A number of Wireless Access Units or wireless jacks ("WAU's") 201 - 203 may be found throughout the floor plan, linked via RF link to the NCU. Additionally, a number of handsets and conventional telephones 300 - 304

whether portable or connected to a WAU may also be found throughout the floor plan. Other electronic devices such as a fax 400 may be included; fax 400 in Figure 1 is shown connected to a WAU 202. (Collectively, WAUs, handsets, telephones or other devices attempting communication with the NCU may be referred to as "remotes".)

Any number of PSTN lines or connections may terminate in one or more NCUs for a particular location according to the present invention. Again, the term PSTN includes for purposes of this document not only conventional circuit-switched telephony networks, but also packet switched data networks, or any other form of network providing access to any set of subscribers or customers, whether provided by twisted pair wireline connection, via fiberoptic or coaxial or other cable connection, or via satellite or terrestrial wireless connection. The PSTN lines may be analog or digital, and may incorporate any desired present or future analog or digital standard, format or protocol. Similarly, WAUs according to the present invention, which may be RF linked to one or more NCUs for a particular location, can be adapted to accommodate any telecommunication, consumer electronic or other required standard, format or protocol, whether analog or digital and can be manufactured and sold individually for that purpose to render communications webs according to the present invention modular in nature with a mix of components to suit every reasonable taste and preference. A WAU may connect to, for instance, a "telephone", such as telephone instrument 300 in Figure 1, a conventional modem, directly to a personal computer via ISDN WAU, to a fax machine via fax WAU, or any other desired electronic device. A number of WAUs and handsets may be employed according to the present invention to accommodate any particular combination of electronic devices the subscriber desires to have connected to the PSTN. Figure 1 is purely a simple hypothetical floor plan in order to provide a modicum of perspective relative to NCUs, WAUs, remotes and other electronic devices as employed in communications webs of the present invention.

In general, the present invention provides wireless networks which can

accommodate various forms of communications devices or systems, entertainment devices or systems, computing devices or systems, utility devices or systems, and any other electronic device or system a user wishes to place in access to content or communications sources or resources external to the wireless network. The networks may be programmed by the user to deliver any form of content or communications to any desired device or system, each such device or system being assigned one or more addresses by the networks. As merely one example, the user may program one or more Network Control Units 100 on the network, using a graphical user interface that appears on a handset 300 already on the network, to match an incoming port or line on the Network Control Unit 100 with a particular computer or telephone 300 in a certain room. When content or communications reach a port on the Network Control Unit 100, it is placed in digital form if not already, assigned the user-allocated address or addresses of the relevant device or system, and placed on a wireless link for reception and rendering by the relevant device or system. The relevant device or system has or is coupled, physically or via air interface, to functionality such as a Wireless Access Unit 201 that senses content or communications addressed to it or the device or system, transforms the content or communication into form usable by the device or system, and renders it for use by the user. Addition of new or circuitry or software to that already contained in the Network Control Unit 100, to allow the network to accommodate and deliver any form of content or communications transport or other protocol, can be done in a modular way, and with ease. The same invention from another perspective can be viewed as providing an infrastructure for managing and distributing content by providing physical devices and systems together with software which form a physical layer with one or more wireless links, which can support and interface with any desired protocols or layers according to any desired model. Thus, as one example, voice over internet communications may be conducted over networks according to the present invention by causing the Network Control Unit 100 to deliver IP packets directly or by inclusion of the packet in transmission frames

directed to IP telephony handsets 300 or computers or other devices connected to Wireless Access Units 200 according to the present invention, or by conversion of the IP packets into another standard or format, such as standard voice format at any point in the network including a gateway for that purpose.

NETWORK TOPOLOGY

In systems of this invention, time is divided into a sequence of equally spaced and contiguous "frames" of equal duration. Each frame is further subdivided into a send sequence and a receive sequence. The NCU transmits during the first part of the frame and receives during the second part of the frame. The transmit interval and the receive interval are nearly equal in duration, so that NCU transmissions take place in the first half-frame, while NCU receptions occupy the second half-frame. Down-link (from the NCU to remote units) half-frames and up-link (from the remote units to the NCU) half-frames are divided into seven "time slots." One of the seven slots in each half-frame is dedicated to network supervision and is termed the "supervisory slot." Figure 2 is a block diagram of an NCU frame. The supervisory slot occupies the "0" slot of each up-link or down-link half-frame. The remaining six slots ("application slots") transport user application data between the NCU and participating handsets, WAUs, or other remote devices.

The aggregate of bits which are transported within a slot are referred to as a slot Protocol Data Unit ("PDU"). As illustrated in Figure 7, all slot PDUs 850 are composed of at least a "preamble" 852 and a forward error correction PDU ("FEC PDU") 854. The FEC PDU 854 contains the information or message that is to be conveyed. An FEC PDU is composed of 217 bits or chips of which 182 chips are payload bits and 35 chips are syndrome bits. The 217 chips are divided into seven FEC blocks of 31 chips each. The first 26 chips of each block are payload bits. The remaining five chips belong to the syndrome.

The supervisory slot PDU has, in addition to the preamble, a 24-bit synchronization code word which, when detected by receiver circuits locates

the leading edge of the FEC PDU. The 24-bit code word field is situated between the preamble and the FEC PDU. Preferably, network format (described below) is used for supervisory PDUs. Supervisory PDUs are used to manage network resources, create and dissolve network connections, and assist in the restoration of failed connections.

At the physical layer, two formats are supported for payload data: (1) Network; and (2) Audio. Supervisory PDUs conform to the network format. In the network format, the 182 payload bits are divided as follows: (1) 148 bits form 9 ¼ 16-bit words that comprise the information content of the message; (2) a two-bit field that comprises an in-band signaling channel (for facilitating the choice of a preferred antenna diversity based upon performance measurements made at both ends of the connection); and (3) 32 payload bits are occupied by a 32-bit cyclic redundancy check ("CRC") remainder. In the audio format, the first 148 bits of the payload are divided as follows: (1) the first 140 bits form fourteen 10-bit audio samples; (2) eight unassigned bits; and (3) two signaling bits; and (4) 32 CRC bits. This transformation (performed by the slot machine as discussed below) is illustrated in Figure 10.

When the network is idle, the NCU may "sleep", waking periodically to detect and process calls originating from the PSTN or to detect a session from a WAU or a handset. At such times, the NCU executes send/receive frames continuously. Downstream supervisory PDUs alternate antenna diversity from one frame to the next frame. If one of the two diversities is in a deep fade for a given path, it is likely that the alternate diversity is not, so that a connection is achievable if the WAU or handset is within range.

The upstream supervisory slot is allocated on a time multiplexed basis to multiple WAUs within the radio domain. Down-link supervisory slot PDUs issue permits to specific remote WAUs according to a list maintained in software. This type of medium access control ("MAC") is characterized by the scheduling of band-width resources by the controlling node, and is sometimes called a Reservation System.

The NCU routinely appoints an up-link supervisory slot as a contention slot. Any remote desiring to open a new session with the NCU may transmit

in an up-link supervisory slot so designated. It is possible for two or more WAUs or handsets to do so concurrently, resulting in a collision. If this is the case, one of the attempts will be acknowledged in a subsequent down-link supervisory PDU transmission. Rather than transmit in the next available contention slot, each WAU or handset that has failed an attempt will allow some random number of contention slots pass before renewing the attempt. When the up-link supervisory slot is used in this way, a WAU or handset wishing to open a new session has a method for requesting a band-width reservation.

Once a WAU or handset is granted band-width resources by the NCU, the WAU or handset may request that one or more slots be dedicated to the session. These non-supervisory slots or "application slots" are intended to carry information in support of end user applications, although there is nothing that would preclude them from being used, for example, as an augmentation of supervisory bandwidth. The NCU may grant or deny all or part of the requested band-width based upon resource availability. The slot is the minimum bandwidth allocation unit. Permission to occupy one or more application slots is granted by the NCU in the down-link supervisory slot payload.

Other forms of systems according to the present invention apportion space on the radiofrequency link or links in other ways. Among them are (1) sending a periodic beacon signal to which all units on the network synchronize and which initiates a period of time in which time slots are assigned to telephony and data communications on an as needed basis; (2) use of conventional or other collision avoidance techniques; (3) use of conventional Carrier Sense Multiple Access (CSMA) techniques; (4) contention based techniques. Any techniques are acceptable which allow voice and data communications to be transported in a satisfactory way that accommodates the inherent latency issues associated with voice communications.

Relevant contention based techniques include a first proposed by ATT named MediaPlex. MediaPlex utilizes centralized contention control in which

an arbitration unit executing on a platform performs contention control by using global history information from previous contention periods in the network. Whenever there is contention for the available bandwidth, the arbitration unit examines the result of the previous contention and assigns access based on the previous results. This arbitration ensures that no one communication is either starved or allowed its unfair share of the available bandwidth. When a station has data to send, it waits until it sees a contention control (CC) frame being transmitted by the arbitration unit. Upon seeing the CC frame, the station sends a reservation request (RR) frame to the arbitration unit. When the arbitration unit receives the RR frame, it reserves a virtual stream (VS) for the requesting station to the access point and for the access point to the destination station. Multicast and broadcast VSs are also possible; for instance, in the form of a single source station to multiple destination stations. The VS is assigned the priority level stated in the RR frame or if a priority level is not specified, a default priority level is assigned. If the station sends the RR by preempting a current transmission, contention does not exist. VS's may be given specific transmission opportunities (TOs) by the arbitration unit. The TOs specify the start and duration times and are scheduled by the arbitration unit in accordance with QoS parameters. Once assigned TOs, the transmitting station can transmit the data or give its TOs to other outgoing VSs from the same transmitting station. Contention (i.e., collisions) can only occur in such systems during the transmission of the RR frames. Should more than one station transmit RR frames to the PC simultaneously, the contention is resolved using global history. Such techniques are advantageous because they offer dynamic scheduling frame-by-frame. Multi-frame scheduling is also possible.

Another contention based technique is offered by a company named ShareWave, Inc. of El Dorado Hills, CA and is known as Whitecap. This technique provides a system with a coordinator that divides the contention free period (CFP) into transmit slots. The coordinator assigns the transmit slots to each station that is requesting bandwidth. Devices are then free to transmit their data during their assigned transmit slot. Synchronization is

achieved with the use of a beacon packet that is transmitted periodically. The access times are negotiated/allocated during what is known as the Admission Control process. The coordinator provides the transmit slot list during the Admission Control negotiation. The requesting stations assess their bandwidth requirements and return the requirements to the coordinator. The transmitting stations keep track of the beacon and start their transmission at the beginning of its allocated transmit slot. A station may start prior to its transmit slot if it detects the last frame from the device owning the previous transmit slot. Once the station is done transmitting, it marks the last frame.

Another contention technique offered by Lucent Technologies under the Blackburst name is a distributed access mechanism without a central coordinator/arbitrator. When a station has data to transmit, it does so for a specified period of time and then schedules the next transmit time. When the station has a scheduled transmit time, it can transmit, if the channel has been idle for a predetermined period of time. If not, the station waits for a predetermined time and and enters into a contention known as resynchronization where the winner is the station that has been waiting to transmit the longest.

Other contention or noncontention based techniques may be used.

NETWORK CONTROL UNIT

Figures 3A through 3C show, in functional block diagram format, embodiments and portions of embodiments of Network Control Units ("NCU's") according to the present invention. Portions of the NCU, as illustrated in Figure 3A, may be implemented in applications specific integrated circuitry ("ASIC") medium. The ASIC portion 450 of the NCU 100 is also used in the handsets 300 and the WAUs 400 and the implementation of certain features in those components will be discussed below. According to a preferred embodiment of the present invention, NCU 100 includes interface circuitry for interfacing with PSTN lines or connections from a switch or other component of the PSTN, whether analog or digital. This circuitry, denominated "Network Interface" 650 as shown in Figure 3A, couples to

conferencing, switching, bridging and accessory circuitry as shown with numeral 660 in Figure 3A. Figure 1 shows the Network Control Unit 100 generally as having access to a public network. Figures 30, 31, 34 and 36 also show various ways of providing access to a public network via devices having wireless access to a public network, or via other non-HWN networks which may have wireless or non-wireless access to a public network, which may include via Network Interface or Interfaces 650. This discussion considers signals in a "downstream" or a PSTN to NCU to WAU direction, from which corresponding signal flow in the opposite direction is apparent.

The Conference Accessory Block ("CAB") components couple signals from the Network Interface corresponding to incoming lines, in a predetermined and programmable manner, with additional functionality, if desired, to downstream circuitry for eventual RF transmission to WAU's and handsets. The switching and bridging components of the CAB are the portion of the Network Control Unit that allow the subscriber either remotely or locally to designate by programming into the NCU which of his or her telephone instruments, computers, fax machines, and other devices connect to various PSTN lines at particular times of day or under particular conditions.

The Slot Machine 645 assembles data from the CAB into frames for transmission to a plurality of transmit and receive slots in a Radio Multiplex Engine and receives data from the radio for delivery to the CAB. In addition, the slot machine 645 performs forward error correction encoding and decoding. Other duties include payload scrambling and descrambling, cyclic redundancy check generation, compression of audio data samples, and the generation of radio controls.

The signals being properly switched in the CAB and routed in the Slot Machine, as designated for the subscriber's devices, are then delivered to the NCU's "Radio Multiplex Engine" ("RME") as shown in Figure 3A with numeral 670. The RME multiplexes the signals as, for instance, by time division multiplex access, or according to any desired format, onto a number of predetermined channels for bandwidth and RF frequency conservation. The multiplexed signals are delivered to Radio Transceiver 680 where the signals

may be conditioned, again multiplexed according to any desired format, and modulated onto an appropriate RF carrier or carriers in a programmable manner or as otherwise desired for transmission to WAUs 200, handsets 300 and other devices if desired.

NETWORK INTERFACE

In greater detail, the Network Interface 650 of the NCU may be modular in design and contains the circuits that connect to the public switched telephone network for accommodating various media, including twisted pair, coax, fiber and wireless, and various modes, including analog, digital or a hybrid. A Network Interface may be modular and portions for all lines may be implemented in ASIC medium to accommodate analog circuits, or services requiring, among other interfaces, ISDN, T-1, CATV/COAX, ATM, micro-ATM, AMPS, N-AMPS, GSM, TDMA digital cellular, CDMA digital cellular, analog or digital SMR (Nextel), PCS, LEO satellite, geosychronous satellite, Internet protocol or any other present or future form of wireless or wireline local loop or other PSTN service including for instance various internet telephony or streaming or other relevant handshaking, session management, quality of service, and other network or other protocols. Relevant protocols include ITU Standards H.323 (as well as standards under that umbrella) and other standards which define real-time multimedia communications for packet based networks; Media Gateway Control Protocol ("MGCP") and other standards which are designed to bridge between circuit switched and internet protocol packet switched networks; Session Initiation Protocol ("SIP") and other session management standards; and Internet Engineering Task Force ("IETF") Resource ReSerVation setup Protocol ("RSVP") and other standards for supporting resource reservations through networks of varying topologies. Quality of Service standards which may be employed include the Lucent Blackburst Standard and the Sharewave Whitecap standard, as well as other standards for ensuring quality of service.

Network Control Unit 100 may also terminate or receive signals from power utilities using standards and protocols such as the X-10 Standard

promulgated by X-10 (USA), Inc. of Closter, NJ or the Powerline Home Networking Specification supported by the Home Power Network Alliance and by Intellon Corp. of Ocala, FL. Other power utility content or communications distribution schemes which do not synchronize content or communications transmissions with power cycles could just as easily be used. As shown in Figure 3B, the Network Interface for a system according to the present invention which accommodates four POTS lines, could take the form of a quad arrangement of independent Direct Access Arrangement ("DAA") circuits 690, each having appropriate transformer, control 702, isolation 703, ring detection 704, and line protection circuitry as required, a two to four wire hybrid 705, and a coder / decoder ("codec") 710. The Si3034 DAA manufactured by Silicon Laboratories may be used. The Network Interface circuitry is accordingly adapted for appropriate isolation, impedance matching, line protection, medium conversion (two wire to four wire) and analog-to-digital / digital-to-analog conversion in order for its output signal 720 to be coupled to a digital signal processor ("DSP") 675. The DSP 675 is a modem DSP with standard modem functions. The bit rate of the modem may vary (e.g., 56K, 28,800 baud, 14,400, etc.). The DSP 675 accepts data from each of the codecs or codec output of a DAA.

Codecs according to the present invention in additional to their conventional functionality also compensate for line loss, mismatch and other incompatibilities with the public telecommunications network by providing superior lowpass filtering implemented in digital signal processing techniques. Codecs 710 encode signals using an 8K or higher sampling rate as in mu-law logarithmic encoding, and may quantize using segments which correlate to expanded length code words. Such encoding also may be conducted using a 10-bit word length rather than the 8-bit length employed in mu-law encoding.

Such encoding techniques are preferably implemented in a conventional 16-bit analog to digital converter such as used for digital audio applications, and decoding is performed in such digital to analog converters. These may be integrated into the ASIC medium employed by the network interfaces according to the present invention. The resulting 16 bit

performance yields an approximately 90 dB or better signal-to-noise ratio over the radiofrequency link, and allows the multiplexing techniques according to the present invention to accommodate the encoded signals. The resulting signal quality in the wireless components of the present invention is commensurate with wireline signal quality. Yet such techniques allow full 56K data rate transport capacity in a conventional 3.1K bandwidth. It is recognized that such performance degrades to conventional performance levels once signals processed according to such encoding are routed to the public telecommunications system, through standard line card codecs and mu-law encoding techniques if not due to line loss.

In addition to the encoding technique described above, codecs of the present invention may encode using an oversampling, decimation, and interpolation ("OSDI") technique. According to the OSDI technique, 16-bit linear quantization and 9.6 kHz or higher sampling rate is initially employed on analog signals. After the oversampling, the signal may be decimated to a lower sampling rate prior to transmission over wireless media.

To reproduce the signal accurately at the other end (e.g., Wireless Access Units), the signal may be converted back into analog form and processed through a reconstruction filter. The reconstruction filter may be digital, wherein the reconstruction would take place prior to digital-to-analog conversion. If the reconstruction filter is analog, the reconstruction would take place following the digital-to-analog conversion. Alternatively, the reconstructed signal may be mixed with the digital portion of the reconstruction occurring prior to D/A conversion and the analog portion occurring after D/A conversion. The signal is then passed to a 4-wire to 2-wire hybrid and coupled out to the RJ-11 connector of the wireless access jack. The decimated signal at the access jack may be interpolated back up to 9.6 kHz or higher sampling rate to simplify the reconstruction filtering.

An echo canceller may be used in conjunction with the mu-law encoding or the OSDI encoding techniques described above in order to minimize near-end echo and thereby improve performance. Since the circuit from the hybrid at the PSTN connection to the hybrid at the access jack is a

four-wire wireless circuit, the echo canceller may be located at either end. The echo canceller may also be split with portions of it located at either end. The echo canceller may be a fixed type echo canceller with preset coefficients that are calibrated to a given line condition. Alternatively, the echo canceller may be adaptive, such that it automatically corrects for variations in line conditions. The correction may occur using either a training sequence preamble that precedes certain transmission. The correction may alternatively occur based on stored coefficients from a previous session. The echo canceller would then adaptively select new coefficients based upon current real-time data.

Network interface 650 may be further adapted to include an additional RJ-11 connector that allows hardwiring to a single-line telephone or existing in-home wiring. This would permit the NCU to manage existing telephones as a resource in addition to the handsets of the web. The NCU may include a dropout relay that automatically switches the hardwired extra RJ-11 connector over to one of the incoming lines in the event of a power failure or a system failure within the NCU.

For any of the wireless local loop or so called fixed wireless services including satellite, the Network Interface may be a wireless modem which includes a radio receiver or transceivers and appropriate modulation / demodulation, coding and decoding circuitry. When the Network Interface is a wireless modem / Radio Transceiver, the NCU 100 operates as a radio transponder or rebroadcast unit, communicating with the PSTN via one wireless protocol, and with the WAUs 200, handsets 300 and other components of systems according to the present invention via the same or perhaps different protocols. This aspect of the invention may be counter-intuitive: If the connection to the PSTN is wireless, one approach is simply to connect directly to any location in the residence instead of relaying signals through the NCU 100. However, systems according to the present invention address a problem this approach would present, because Radio Transceivers that interface to the PSTN typically must comply with elaborate air interface standards having precise frequency control, well-defined RF bandwidth,

higher transmit power (to accommodate the greater distance to a cell tower or PCS antenna), better receiver sensitivity, higher battery drain and shorter battery life, and increase complexity and expense. A handset 300 or a WAU 200 according to the present invention, however, is a far simpler and less expensive device which need only accommodate the present invention's less stringent internal air interface standards, but nevertheless retain the functionality to provide corded quality and reliability for indoor / nearby outdoor service that is inexpensive, compact, lightweight, flexible and manufactured and sold, if desired, tailored to specific devices such as faxes or various digital standards which not every subscriber may wish to employ.

Incoming connections to the Network Interface 650 could be physically separate twisted pairs as in the case of analog POTS lines where each line terminates from the PSTN via an independent twisted pair; alternatively, each incoming circuit can be multiplexed over a single twisted pair, such as two digital circuits provided by a conventional, basic rate (2B + D) ISDN line. An optical fiber connection could provide digital voice service, MPEG video and other services over a single optical fiber which could be de-multiplexed (multiplexed for outgoing or upstream information) in the Network Interface, and incoming lines could be virtual. That is, additional lines could be assigned on an as needed basis and charged accordingly. For example, a subscriber might have connection to one line from 10:00 p.m. to 7:00 a.m, two lines from 7:00 a.m. to 9:00 a.m. and four lines from 9:00 a.m. to 7:00 p.m. and be billed accordingly for the partial use. As discussed below, the CAB 660 can be programmed to accommodate changes in the PSTN connections in real time in order to distribute bandwidth and service as desired among various WAUs 200, handsets 300 and the other end user interface devices.

EMBEDDED PROCESSOR

The NCU 100 includes an embedded processor 700, such as a 32-bit RISC microprocessor with 16 bit compressed instruction mode. The processor executes both 32-bit and 16-bit instructions from either external FLASH 715, SRAM 717, or internal SRAM 719 memories. The processor

700 has a multiple- stage instruction pipeline. Pipelining is used so that all parts of the processing and memory systems can operate continuously. While one instruction is being executed, its successor instruction is being decoded, and a third instruction is being retrieved from memory 715, 717, or 719. An external bus interface unit 723 interfaces the processor's internal bus 730 to an external 8-bit or 16-bit bus 737.

Several registers are used to assist the processor in performing its functions. A control register selects the operating mode (NCU or remote device), starts or arms the slot machine, swaps the data from FLASH ROM 715 with the internal SRAM 719, enables the various audio state machines in the CAB, enables the programmable counters, controls the state of the com port signals, and disables the FEC error correction circuits for test purposes. A status register records the occurrence of synchronization code word detection events and monitors the states of the Ring Indicates signals of the PSTN lines. Timers 739 are used to enable the real-time aspect of the NCU 100. An interrupt register 738 collects all of the interrupt sources and presents an interrupt to the processor 700. Serial ports and communications ports 741 allow expansion cards to be coupled to the NCU 100.

CONFERENCE ACCESSORY BLOCK

Conference Accessory Blocks ("CAB's") according to the present invention may include a PSTN interface 720 and a switch 725 as shown in Figure 3A. The PSTN interface 720 is an audio interface between the CAB and the DSP 675. The interface 720 includes receive functionality for performing serial to parallel conversion on data from the DSP 675, routing received data to the appropriate audio or communications channel, and establishing timeslot synchronization. The interface 720 includes transmit functionality for generating the DSP transmit timeslot counter, choosing which audio/data to transmit based on the timeslot counter, setting the least significant bit in the timeslot to zero and clear the least significant bit in other timeslots, and performing parallel to serial conversion on data. The interface 715 may include additional functionality as required for coupling data from the

DSP 675 to the switch 725.

The switch 725 is preferably implemented as shown in Figure 3C, including a multi-port RAM 750 and a conference bridge 755, and a tone injection module 758. The processor 700 communicates with the switch via a multi-port RAM 750 that allows software to exchange data with the network. The multi-port RAM 750 includes an address table 752 and a plurality of ring buffers 754. The ring buffers provide temporary elastic storage that blends asynchronous network format data and isonchronous audio format data in the send-receive cadence of the half-duplex time-division-multiplexed network. Ring buffers are assigned to each DSP input port, DSP output port, conference bridge input port, conference bridge output port, tone injection port, outbound slot, and inbound slot. The starting location, length, and fill level for each buffer is established by writing to the multi-port RAM address table 752. Each table entry describes one ring buffer. Input ring buffers accept data from the DSP 675 via the PSTN interface 715. Output ring buffers provide data to the DSP 675, the slot machine 645, and a conference bridge 755. Preferably, PCM encoded audio samples from the DSP and slot machine are converted to 16-bit linear two's complement format and multiplied by four before being written to input ring buffers. Two's complement audio samples are divided by four and converted to eight-bit PCM before being routed back out to the DSP 675 and slot machine 645.

Conference bridge 755 provides hardware support for multiple parties to participate in a conference. Participants may include several handsets in the local radio domain and one or more of the PSTN lines. The conference bridge includes several inputs corresponding to the number of codecs and application slots. Any combination of the codec inputs and receive slots may be summed to construct an output. The outputs may be mapped to any one of the codec outputs or transmit slots. The conference bridge 755 receives all inputs from input ring buffers and delivers all outputs to output ring buffers. Ring buffers are mapped to the conference bridge using the multi-port RAM address table 752 and can, therefore, be assigned arbitrarily by software. Preferably, however, the conference bridge output that is intended for a

particular participant should not contain the contribution of that participant. Thus, a given conference bridge output can never include contributions from more than n-1 of the n sources.

Near the beginning of each audio cycle, state machine circuits automatically load the conference bridge input from ring buffers identified by the contents of the corresponding assigned multi-port RAM address table entries. During each audio cycle, the output are computed by summing the contributions of participating inputs for each output, writing the output to a designated ring buffer, and repeating the process until all of the outputs have been processed.

As illustrated in Figure 3A, various telephony components 775 may be coupled to the CAB. For example, telephony block 775 may include Dual Tone Multi-Frequency ("DTMF"), Call Progress Tone ("CPT"), and CPE Alerting Signal ("CAS") detection and generation. DTMF and CPT detection and generation is used for detecting and generating tones for tone dialing, and tones and cadence for call progress monitoring, respectively. The CAS decoder is used to detect the presence of Caller ID-Call Waiting signaling. The tone injection module 758 handles the routing of mixed tones from the telephony block 775 to the input ring buffers of the CAB 750.

CAB 660 is preferably coupled to processor 700 via bus 730 and/or an external computer and/or network or server, if desired. The external connection may be directly by bus or synchronous connection, or via any of the PSTN lines 640. In systems according to the present invention having multiple NCUs, CABs 660, processors 700 and other components may be coupled and/or networked among various NCUs and/or external / or server control capacity.

For voice services, the CAB 660 may function similar to a central switchboard and conference bridge routing each line to one or more Wireless Access Units 200 and/or handsets 300 via the slot machine 645, as programmed in processor 600. Multiple lines 640, handsets 300, telephones connected to WAUs 200, and other devices may be conferenced to form any number of permutations and combinations of conferences. One wireless

handset can call another without using any of external lines 640 simply using the allotted time slots, codes or RF channels involving the two handsets 300, or telephones connected to a WAU 200. A conference call of any two or more internal handset or telephone devices can similarly occur. Calls or conferences among multiple devices on multiple networked or shared NCU's can similarly occur.

The CAB 660, like other components in the NCU, the WAU's and the handsets, can be implemented in analog circuits including relays, transistors, CMOS media or any other application specific or nonspecific analog components and/or integrated circuits, but preferably signals arriving at CAB 660 are digital so that CAB 660 may be implemented entirely digitally.

CABs 660, according to the present invention, are adapted to route and direct data signals, such as, for example, when using external data services via Internet or internal networks within the subscriber's location. In the voice case, virtual circuits may be established for each call which can remain in place for the duration of a call. In the data case, a Carrier Sense Multiple Access ("CSMA") or packet switching protocol can be employed, among other formats or protocols, in order to support a larger number of bursty devices. A combination of virtual data circuits and CSMA can be employed if desired. In similar fashion, CABs 660, according to the present invention, are also adapted to accommodate voice and data traffic simultaneously, routing traffic and managing resources as desired.

NCU's 100 according to the present invention preferably include a standard connector such as an RJ-11 connector which may be hardwired to a single line telephone or connected, for example, to existing in-home wiring. This connector permits the NCU 100 to manage the existing telephone or wiring as part of its network, perhaps permitting them to answer any ringing line. Alternatively, a POTS NCU 100 could have a drop out relay or FET circuit which may automatically switch the existing wiring over to this connector in the event of a power failure or a system failure. If the NCU 100 is equipped with backup batteries or other auxiliary power, it may continue to function either until mainspower is restored or its batteries become exhausted

in which case it drops off-line and switches to the emergency bypass routing to the external connector.

Processor 700 according to the present invention commands switching, routing, RF, accessory and other functionality implemented in CAB 660, Radio Transceiver 680 and other circuits in NCU 100s according to the present invention. processor 600 could be a small micro-controller set, although more processing power may be required to accommodate ISDN and other digital interface NCUs 100. Then, external PCS 687 and, if desired, servers, may participate in the control functions. A very simple algorithm by which the processor 600 governs CAB 660 for the topology shown in Figure 1 is shown in Figures 11A and 11B, in which, step-by-step, lines 640 are matched in the CAB 660 to various WAUs 200, handsets 300, and other devices. The control algorithms and programming itself may occur locally as by an interface 689 which may be implemented in buttons or a keyboard, by PC 687 or external connection, including network or PSTN.

Alternatively, systems of the present invention are adapted to permit control of the NCU 100, including Control Processor 685 and CAB 660 from a remote service center so that a subscriber can call the service center in the event the subscriber feels technically short of the task of programming his or her NCU to accommodate various WAUs 200 and handsets 300.

PC and other external connectivity leverages on higher intelligence of the PC, additional mass memory functionality for updates and databases and similar applications, the more convenient user interface, and more elaborate applications software such as, for instance, directory management, spreadsheets and database managers.

SLOT MACHINE

The slot machine 645 takes data from the multi-port RAM ring buffers 754 and creates a serial stream of data. This data is broken down into 16 slot PDUs: 14 application slot PDUs and 2 supervisory slot PDUs. A description of the format of these PDUs is described above.

The slot machine 645 includes downstream functionality for

assembling slot PDUs from data contained in the multi-port RAM ring buffers 754 and mapping outbound slot PDUs to transmit slots. The slot machine 645 includes upstream functionality for assimilating and disassembling inbound slot PDUs and delivering extracted payloads to multi-port RAM ring buffers 754. The transmit and receive portions of the slot machine 645 are shown in FigureS 8A and 8B, respectively.

As illustrated in Figure 8A, the slot machine 645 merges multiplexed data (via multiplexer 829) from the multi-port RAM ring buffers 754 and signaling bits from a transmission signaling bit register 838 into outbound slot PDUs. Linear-to-PCM translation of data from the ring buffers 754 may occur prior to merger. Scrambler 839, scrambling preset register 841, and CRC generator 843 are used to scramble the payload and provide CRC generation, detection, and reporting across the payload fields of the slot PDUs.

The slot machine further applies forward error correction ("FEC") in an FEC encoder 845. FEC encoding and decoding is performed using single-bit hard decision and double-bit soft decision error detection and correction. Soft-decision decoding provides additional coding gain above the gain offered by a simple hard-decision decoder. This occurs because a hard-decision decoder is only capable of correcting a single bit error, while a soft-decision decoder corrects all single bit errors and many two-bit errors as well.

An exemplary soft-decision decoder is illustrated in Figure 9. As shown, the soft-decision decoder 915 has two inputs: (1) a one-bit sign 917; and (2) an 8-bit magnitude 919. As the chips of the codeword are fed into the decoder, the weakest two chips are located. The decoder uses the fact that the magnitudes of errored chips tend to be the weakest. The encoder forms three candidates for correction: (1) an unmodified codeword; (2) a codeword with the weakest chip flipped; and (3) a codeword with the second weakest chip flipped. These three candidates are then fed into three parallel hard-decision decoders 927 which identify an additional errored bit. To choose the proper candidate for output, the decoder selects the decoded vector with the smallest Euclidean distance from the original received message. To

determine this, the decoder constructs a decision metric for each candidate consisting of the weight of the flipped bit (if any) plus the weight of the corrected bit (if any) and chooses the vector with the smallest metric. A comparator 935 is used for this purpose. The entire algorithm is pipelined and implemented in parallel such that after the 31st bit of the codeword is received, the first corrected output bit is ready a few clock cycles later, coincident with the arrival of the first bit of the codeword. Dual-port RAMs 921, 923 are employed as storage for the magnitude of the input vector.

The task of mapping from a given syndrome to its corresponding error location is avoided by using an index counter that counts from 1 to 31 using the natural sequence of syndromes that would result from an error in each possible location of the codeword from left to right. This allows direct indexing of the codeword buffer by the corresponding syndromes without requiring a lookup table. Such a counter may be a properly seeded feedback shift register syndrome generator operated in reverse (i.e., with the direction arrows reversed so as to run backwards).

The slot machine 645 appends preamble and synchronization code words to outbound PDUs using a preamble generator 853 and a codeword generator 857. The slot machine may include radio controls for the radio circuits.

The receive side of the slot machine is illustrated in Figure 8B. As illustrated, data from the radio multiplex engine 670 is coupled to an FEC decoder 861. The FEC decodes data using the single-bit hard decision or double-bit soft decision error detection and correction discussed above. The payload of the data is descrambled in a descrambler 863. Additional CRC checks may also be performed. The descrambled data is transferred to a shift register 865, where the slot machine 645 extracts signaling bits from the PDUs and copies these bits into a receive signaling bit register 867. Multiplexed data is then transferred to multi-port RAM ring buffers.

Slot machines for non-fixed frames can take any form and operate as desired. For instance, to accommodate contention based techniques, the slot machine is responsive to the circumstances presented by the network rather

than based on fixed length frames. According to the Whitecap technique, for example, there is a periodic beacon that provides synchronization for all stations operating on the wireless LAN. Depending on the number of stations requesting contention free service, there is a variable number of dedicated time slots for each of the stations. However, the time slots can vary in duration depending on the bandwidth requirements and the priority of the service. Even after a time slot has been specified, a station may finish its transmission and release it remaining time to the device of the next time slot. A slot machine that operates with Whitecap therefore uses no fixed timing structures; instead it could, for instance, rely on timers that are specified by the coordinator for the generation of slot boundaries and similar parameters.

The MediaPlex technique referred to above requires even more flexibility. There are no fixed time slots and the size of the allocated bandwidth can vary from frame-to-frame or from multi-frame-to-multi-frame. With the exception of the beacon that emanates periodically, the slot machine for MediaPlex is preferably totally programmable in the timing information that it generates, to the extent of being almost asynchronous in operation.

The Blackburst technique is totally asynchronous in operation so that the individual stations provide the necessary timing information and synchronization by themselves.

RADIO MULTIPLEX ENGINE

The output serial data stream from the slot machine 645 (in the form of slot PDUs) is coupled to a radio multiplex engine 670 according to the present invention which can comprise a digital logic block that implements any of the following functionality: multiplexing / demultiplexing, preferably but not necessarily TDMA / TDD (Time Division Multiplex Access / Time Division Duplex), forward error control and general error management, speech compression if required, code division multiplex and demultiplexing, if any, hopset generation if any, and other critical timing, synchronization and coding functions critical to the operation of the systems according to the present invention.

RME signals are coupled, in systems of the present invention, to wireless Radio Transceiver ("RT") circuitry 680 as shown in Figure 3A. The RT 680 may be a low cost multiplexed Radio Transceiver or set of transceivers which provides proper modulation (e.g., DBPSK) onto RF carriers as desired with or without multiplexing and duplexing according to any of the following formats or others: TDMA / TDD, TDMA / FDD, CDMA / FDD, CDMA / TDD, FHMA / TDD, or FHMA / FDD. The primary function is to achieve transmission of multiple simultaneous independent data streams to WAUs 200 and handsets 300. Connectivity may be provided using any form of modulation, including spread spectrum (whether direct sequence or frequency hopping), or ultra wideband or similar or any other desired techniques. Spread spectrum and, in many respects ultra wideband techniques are useful because they are less susceptible to interference, they are relatively secure, and they offer significant bandwidth potential.

In addition to radiofrequency transmission techniques according to the present invention, Network Control Units 100 may support any other desired air interfaces or network standards including the nascent Bluetooth standard discussed further below, and wireless network standards such as the HomeRF Working Group standards, the IEEE 802.11 standards, the Digital European Cordless Telecommunication Standard ("DECT"), the Personal Communications Service standard ("PCS") and Wideband Frequency Hopping Spread Spectrum (As discussed in FCC ET Docket 99-231). In this way, networks according to the present invention can be linked to other networks, or can incorporate other network protocols in order to accommodate devices or systems which operate on such other networks. Modularity of systems according to the present invention means that this can be accomplished either by supporting the standards in the Network Control Unit 100, or in a device 200, 300 which is in communication with Network Control Unit 100 using the wireless links according to the present invention. For example, functionality which supports 802.11 standards in the network control unit 100, can be implemented in the network interface to treat such standards as simply another external resourece to be handled alongside

PSTN and other interfaces, or it can be implemented in other sections of the network control unit to support conversion to such standards and a separate radiofrequency link to devices addressable or non-addressable on the network. Implementation can occur in any number of ways as desired.

IEEE 802.11 networking standards which may be suitable include 802.11, 802.11a and 802.11b. IEEE 802.11, the original standard, was finalized in 1997, and accommodates three physical layer options (PHY), infrared, direct sequence spread spectrum and frequency hopping spread spectrum. Both forms of spread spectrum layer PHY options operate in the 2.4 GHz ISM band, which is available throughout most of the civilized world. 802.11 uses relatively high transmission power for good working range. Spread spectrum techniques reduce errors and interference. IEEE 802.11a uses orthogonal frequency division multiplexing ("OFDM") and the Unlicensed National Information Infrastructure ("UNII") 5.8 GHz band, and supports fast data rates of 6, 12, and 24, and optionally 9, 18, 36, 48 and 54 Mbps with a robust physical layer. However, OFDM requires greater frequency accuracy to operate, and the fast data rates added to high frequency limit operation to a short range. IEEE 802.11b uses complementary code keying, operates in the 2.4 GHz ISM band and supports data rates of 1, 2, 5.5Mbps and 11Mbps in addition to backwards compatibility with older generation 802.11. 802.11b thus supports high data rates in a frequency band that is available throughout most of the civilized world. Again, however, operating ranges are limited because of the high data rate combined with high frequency. Backwards compatibility also requires high overhead and thus creates some inefficiencies. Nevertheless, IEEE 802.11 devices and wireless networks are becoming more widespread; the present invention recognizes that they can and should be accommodated by networks according to the present invention in order to permit handsets 300 and other devices on such networks to interoperate with 802.11 devices and systems as well as devices and systems according to any other standards or protocols which exist currently or which may occur in the future.

Conveniently, the RT circuitry 680 need not conform to any error

interface standard, since it communicates only with like equipment and usually does not interface to the PSTN or any other public network except via a separate, higher quality transceiver if any is implemented in the Network Interface 650 or connected to it.

Via an independent communications protocol, the RT unit 680 can communicate with other NCUs 100 that fall within radio range. The NCUs 100 can share hopset data interference records, timing and usage information, all toward the end of avoiding one another's transmissions. In like manner, the components of each system, NCUs 100, WAUs 200, handsets 300 all transmit at the lowest power possible to provide reliable communications, using power management sensing and response to the circuits. In this manner, each system minimizes its "radius of interference," the approximate circular area surrounding a given system within which it is capable of generating interference in other systems operating in the same band.

HANDSETS

Figure 4 is a block diagram of a handset 300 according to this invention. The handset 300 includes the ASIC 450 of the NCU, as illustrated in Figure 3A. The ASIC's primary function within the handset is to interface the radio 670 to an audio codec 473 as well as an LCD and a keyboard.

The ASIC 450 is similar to the ASIC shown in Figure 3A. Two serial ports 437, 439 of the ASIC (Figure 3A) are used to communicate with a keyboard 467 and LCD 469 on the handset. In the NCU 100, these input/output ports 437, 439 may be used for other I/O operations. In addition, a synthesizer port may allow the processor 700 to communicate with a frequency synthesizer. A codec 460 encodes and decodes audio signals between a microphone 455, a speaker 457, and the ASIC 450.

WIRELESS ACCESS UNITS

Wireless Access Units 200 according to the present invention may be of two general sorts: (1) analog for a wireless telephone jack function such as

one that can accommodate a telephone or a conventional modem; or (2) digital, for a wireless computer or digital device connection (such as DB-25, USB, Ethernet, ISDN-ST, PCMCIA or similar serial or parallel data communications connection).

Figure 5 shows one form of analog WAU 200 according to the present invention. The analog WAU 200 may include an NCU ASIC 845 as shown in Figure 3A. The ASIC 450 includes a radio Transceiver 800 linking WAU 200 via RF connection to the radio 670 of NCU 100. In addition, the WAU 200 includes circuitry that provides basic subscriber loop functions of battery, over voltage protection, ringing, supervision (off hook sensing), codec, hybrid and test functionality (so called borscht) functionality. The codec employs the expanded code word encoding / decoding techniques described above with reference to Network Interface 650. The analog WAU 200 of Figure 5 may be implemented in a small unit which resembles a wall transformer with one or more RJ-11 jacks on the back or side, and it can, if desired, draw power from any AC outlet and provide an analog telephone type connection to a computer modem, a fax machine, a telephone answering device, a standard telephone or any other device that connects with a standard RJ-11 jack. The unit is transparent to caller ID information, and passes it through. Similarly, the unit passes through coded ringing and other custom signaling. Its power supply provides power for standard telephones which are line powered. Its high voltage ring generator rings telephones with the standard 60 volt rms., 20-Hz ring signal. Note that while this unit is typically though not necessarily "wired" to the AC power wiring and therefore is not totally "wireless," the length between this unit and the incoming lines 640 connected to NCU 100 is wireless. It therefore eliminates the subscriber's need to place telephones where telephone outlets are located. Battery power, if employed, provides even more flexibility in location.

A digital Wireless Access Unit 200 of one sort according to the present invention is shown in Figure 6. Such a Wireless Access Unit 200 can provide wireless connection to computers, computer peripherals, ISDN-ST telephone sets and other digital devices. Since the radio link used in systems according

to the present invention is digital, the digital circuitry in the Wireless Access Unit 200 principally performs a buffering, error control, and protocol conversion function. The external digital interface can take many forms, including DB-9, DB-25, the standard serial port connector; USB, the universal serial bus standard; parallel-port (printer) connection; Ethernet; 10-base-T; 100-base-T, Fast or Gigabit Ethernet; PCMCIA and others. Unlike the analog WAU 200, the digital WAU 200 couples to the NCU ASIC via an internal UART module 487 in the ASIC (see Figure 3A). Digital Wireless Access Unit 200, like analog Wireless Access Unit 200, may be main or battery powered, so that they may provide untethered convenience to the user.

The WAU circuitry described herein may be incorporated into a PCMCIA card. The card is a self-contained wireless transceiver that plugs into the PCMCIA slot of a portable computer or any other device that uses PCMCIA interfaces. The device couples to the PCMCIA slot using a simple cable or via a bus, such as PCMCIA, PCI, ISA, or any other known data/communications bus. Unlike the standard WAU, however, the card receives power from the PCMCIA slot. The PCMCIA WAU may act as a digital interface to a standard WAU.

The WAU circuitry may further include automatic frequency control circuits that include software for maintaining synchronization of the WAU with NCU transmissions. Each WAU observes the rate of oscillator drift (between the WAU and the NCU) and corrects for it by modulating a DC control voltage applied to a Voltage-Controlled Xtal Oscillator serving as the local time base. The oscillator frequency is pulled in a direction which causes the average frequency of the WAU oscillator to equal that of the NCU oscillator. The time constant on the correction is very long, so many frames may pass during the initial automatic frequency control ("AFC") acquisition. Once the AFC is acquired, it needs only small and infrequent corrections to remain "locked." This function may be performed digitally using numerically controlled oscillators, among other ways.

WIRELESS CONTROL / MONITORING ACCESSORIES

Systems according to the present invention can also perform many control and monitoring functions at a subscriber's location for convenience and increased efficiency. For instance, as illustrated in Figure 14, an entry system within a home, business or other location 1400 may be coupled to systems of this invention for facilitating the wireless control of entry to a location. In a preferred embodiment of such an entry system, the system includes a wireless doorbell 1470 coupled to the exterior of the location and a microphone/speaker 1480 coupled to the exterior of the location proximate the doorbell 1470. An intercom key on the microphone/speaker 1480 allows the microphone/speaker 1480 to switch between microphone functions (when depressed) and speaker functions (when not depressed). The home entry system alerts the residents of the home or small business 1400 to visitors at the door. In normal operation, a visitor may press the doorbell 1470 to cause a bell wired to the doorbell to ring within the home. The visitor may then announce himself by pressing the intercom button on the microphone/speaker 1480. A microphone/speaker within the location 1400 allows the resident to respond to the visitor.

In the present invention, the doorbell 1470 and microphone/speaker 1480 are coupled (wireless or wired) to one or more WAUs 200. The WAU 200, in turn, is coupled wirelessly to an NCU 100, as described above. When a visitor presses the doorbell 1470, the doorbell emits a coded ring to the WAU 200. The doorbell 1470 may also be directly coupled to the NCU 100. The NCU 100 is configured to receive the coded ring of the doorbell of the WAU 200. The NCU then transmits audio signals from the microphone/speaker downstream to a handset 1490 within the range of the NCU 100. Similarly, upstream signals from the handset 1490 are transmitted to the microphone/speaker 1480. Thus, when the visitor presses an intercom key, the NCU places the subscriber in full duplex communication with the visitor. The subscriber may speak with the visitor via a handset 1490 in the location 1400. Audio communications between the handset and the microphone/speaker take place as described above.

The handset 1490 may be further configured to open an electronic door upon actuation of a button on the handset 1490. Specifically, a door to the location 1400 may be locked using an electronic lock or similar locking device. The lock, in turn, is coupled (wirelessly or wired) to a WAU 200 or directly to the NCU 100. When the subscriber actuates a button on the handset 1490, the NCU is configured to transmit the appropriate signal to unlock the electronic lock. The visitor may then proceed through the unlocked door.

Figure 15 is a top plan of a location 1500 using the system of this invention with a security system. The security system includes a plurality of security sensors 1530 coupled to doors and windows of the location 1500. In addition, a motion sensor 1536 attached to a wall of the location senses motion within a predetermined range. Each of these sensors is electronically coupled (wired or wireless) to a central security station 1540 within the location 1500. Additional sensors may be coupled to smoke detectors, CO detectors, and fire alarms. In addition to equipment for monitoring and modifying the sensors, the security station 1540 may include communication equipment coupled to a remote security dispatch station. In this invention, the station 1540 also includes a line coupled to a WAU 200 for coupling signals between the station 1540 and the NCU 100.

The subscriber may configure the security system using a handset 1590. By calling the NCU over one of the PSTN lines, the subscriber may access a menu for the security system. The subscriber then may activate certain sensors remotely using the menu. The subscriber may also establish dates and times for activating the sensors. In addition, the subscriber may use the handset to dial the remote dispatch station directly for assistance.

In operation, the NCU 100 periodically polls the sensors for activity via the security station 1540. The NCU may be configured to monitor particular sensors and disable others. When a sensor is activated, the NCU 100 may transmit a distress call to a handset. The distress call may be in the form of a simple ring or a loud "beep" to immediately alert the subscriber. When the subscriber answers the handset, the distress signal ceases and the

subscriber may use the handset in its normal operation. The NCU may be further configured to automatically dial an emergency response location, such as a police station or a fire house, when a sensor is "tripped".

Another wireless application for a system of this invention is a wireless thermostat. The thermostat may be set remotely by the user using a remote handset. Specifically, the subscriber may "call" the NCU via one of the PSTN lines coupled to the NCU. The NCU is configured to play a series of messages to the subscriber describing configurable aspects of the thermostat. For example, the subscriber may be allowed to directly set the temperature, turn on/off heating and air conditioning, and, establish dates and times for automatically turning on/off the thermostat. The NCU would then transmit the appropriate signal to the thermostat for such control directly or via a WAU. Similarly, thermostat information may be transmitted to a repair center using a PSTN line or via the internet using a TCP/IP connection. The repair center may use information transmitted by the NCU to make service calls and dispatch repair personnel.

Other "utilities" may be monitored using the system. For example, the system may be used as a meter reader to monitor utility usage within a particular location. A utility metering device may be attached to the appropriate utility line and coupled to the NCU 100 via a WAU 200. A meter reader driving along the street could then access the information remotely using a device that receives signals remotely from the NCU. Alternatively, the NCU 100 may use one of its PSTN lines to transmit information from the utility metering device back to a utility company. This would eliminate the need for the meter reader.

The NCU may also be coupled to a stereo, radio, CD player, or other audio equipment using an audio connection. The NCU may be configured to transmit audio signals from the audio equipment to a wireless stereo device, such as a "Walkman"-type device ("Walkman" is a registered trademark of Sony Corporation) via a WAU. The wireless stereo device may include functionality for adjusting features of the audio transmission, such as the radio station, the volume, the treble/bass, and/or the play order of CDs.

Similarly, the NCU and WAU of this invention may be used as a "music on demand" ("MOD") system. Figure 16 illustrates the use of this invention for the purposes of MOD. As illustrated, the NCU 100 includes a built-in modem 120 coupled to a PSTN line. The modem is used to dial a service provider for connection to the Internet 1650. Specifically, the NCU accesses a music publisher's web site or FTP site 1675. The NCU downloads musical data 1678 from the site 1675 in a digital format (e.g., mp3) suitable for transmission on a wireless digital playback device 1640. The NCU then stores the musical data in memory. Unlike current system that download digital music, however, the system of this invention provides a more secure system for publishing music on the Internet. Rather than downloading the song or musical composition to a computer, the song is downloaded to the NCU 100 where it may be deleted or played until a paid-up license has expired.

In operation, the subscriber uses a wireless playback device 1540 coupled to the NCU 200 by RF link. The device 1540 may also be incorporated into a stereo loudspeaker or similar audio component. For instance, wireless mp3 players which may include headphones could be used, as may mp3 players connected to Wireless Access Units, as could various forms of stand alone Internet appliances, some or all of such devices using the Network Control Unit or functionality associated therewith as a distribution point. Various forms of content may be distributed including file downloads, streaming audio or video, file upload, various alarm, security or other home-related information, or any other content desired. The wireless playback device 1540 includes an interface that allows the user to select a particular musical selection, to move quickly forward or backward within a musical selection, and to move quickly forward or backward through several musical selections. In addition, the device 1540 allows the user to adjust the volume control and other audio characteristics of the playback. When the subscriber has completed listening to a selection, she may delete it from the NCU. This system may also be used for the downloading of audible files,

such as spoken-word books encoded into a special format. The format used by Audible Inc. or the ubiquitous mp3 format may be used, for example.

The transmission and storage of digital images from various sources is yet another wireless application for the system of this invention. Rather than using cables and videotape to transmit and store images, a wireless video camera may be coupled to the NCU via a WAU 200. Alternatively, the video camera may be coupled directly to a computer via a wireless data link in the system. Digital images from the camera may be transmitted onto the Internet or to a local computer where the images may be stored.

Another example coupling audio/visual information and the system of this invention is a baby monitoring system. A wireless baby monitor that includes a camera and an audio device may be located in a baby's room. The camera captures video images of the child and/or an audio device captures sounds of the child. The baby monitor is coupled to the NCU 100 via a WAU 200. The NCU 100 is configured to transmit signals received from the baby monitor to a wireless handset. The video image may be displayed on a black and white or color LCD screen of the handset, or an organic electroluminescent panel could be employed. A handset speaker emits the sounds transmitted by the audio device. In addition, video images may be transmitted by the NCU to a particular video monitor, such as a television.

Images and sounds may also be transmitted to the Internet using a modem and PSTN connection within the NCU. This data may be stored at a particular web site for access by others. Thus, parents may access the web site to monitor their babysitter's activities while away from the home.

Figure 17 illustrates the use of the system as a wireless IP telephony tool. Cameras 1710, 1720 and headsets 1715, 1725 located in remote locations transmit video and audio information, respectively, to respective computers 1730, 1740. The computers are remotely coupled to respective NCUs 100a, 100b via WAUs 200a, 200b. The NCUs 100a, 100b transmit the audio and video information to each other using a PSTN line. Thus, two subscribers may agree to conduct a videoconference at a particular time. At the designated time, an application on each computer may be launched to

capture information from the cameras and headsets. This information is then transmitted to an NCU that sends it on to the other NCU via the PSTN.

The system of this invention may be used to monitor wireless medical devices in a hospital, as well. Medical equipment, such as heart monitors and oxygen monitors may be coupled to the NCU 100. The monitors include sensors attached to a patient's body for monitoring heart beat rates and oxygen intake. Other medical equipment also may be used. The NCU 100 may be configured to monitor status information from these medical devices for one or several patients. This information may be collected and analyzed by the NCU. When the information indicates that care is required, the NCU may be programmed to transmit emergency calls to medical personnel using one or more handsets. For in-home care, the NCU may be configured to notify medical personnel using a PSTN line, rather than via handsets.

In addition, individual handsets may be monitored and located using handset locator information programmed into the NCU controller. For instance, NCU controller may be programmed to monitor the extra RJ-11 jack for particular commands or patterns. Thus, when an individual enters a particular code into a handset (e.g., "****"), the NCU sends a locator signal to one or more handsets. The handset, in turn, emits an audible signal. In this manner, handsets may be easily located throughout the house.

IP TELEPHONY

Figure 17B illustrates systems of the present invention accommodating Internet Protocol telephony. The system may be modified for use in IP telephony simply by adding a transcoding device 937 to the NCU 100. IP telephony allows voice data to be transported across the internet using suitable internet telephony standards. While one participant (the subscriber) uses systems of the present invention to transmit and receive voice data, the other party may be using a standard voice telephone, a computer, or a system of this invention. In addition, intermediate service providers may intercept data between the participants and provide additional functionality.

For transmission of quantized voice, a handset 200 converts voice signals to 64K mu-law encoded data, as described above. This encoded data is transmitted via RF link to the NCU 100. The data may then be compressed in the NCU to conserve bandwidth or to provide broader end-to-end compatibility between the participants. The transcoding device 973 performs this compression. The compression converts the 64K data to 8 Kb/s, 6.3 Kb/s or 5.3 Kb/s data, as required by IP telephony standards. For high-bandwidth lines (e.g., DSL), the data may be transported as 64K data.

The NCU 100 further includes functionality for converting the data to Internet Protcol packets. Thus, the compressed data may be packetized into IP packets and headers and other data manipulation may be added to the packet, as required by the protocol. The data is then transported via a modem in the NCU to the PSTN or directly via a digital line (e.g., ISDN).

On the receive side, the recipient may use a standard telephone 949 to receive the voice data over the PSTN. Alternatively, the recipient may use a computer or other digital device to receive the digital voice data for conversion to standard quantized voice.

The NCU may also perform the selection of IP or packet-switched network for the transmission of quantized voice. The NCU may use an algorithm, such as a least cost routing profile to determine the most cost-effective solution for routing data. This analysis may incorporate various rates for the transmission of data during certain times of the day or certain days of the week. This information may be updated daily using a remote server that communicates with the NCU.

In sum, voice over internet communications may be conducted over networks according to the present invention, among other ways, by causing the Network Control Unit 100 to deliver IP packets directly or by inclusion of the packet in transmission frames directed to IP telephony handsets 300 or computers or other devices connected to Wireless Access Units 200 according to the present invention, or by conversion of the IP packets into another standard or format, such as standard voice format at any point in the network including a gateway for that purpose. According to another aspect

of the invention, enhanced internet connectivity is provided by employing enhanced storage and processing of internet addresses. Such storage and processing capacity, which is referred to as "server" capacity, can form part of the circuitry of the network control unit or can subsist as stand-alone functionality connected to the network control unit, or it can be located outside systems according to the present invention.

As an example of benefits associated with such storage and processing, the system can contain an internet protocol address server, such as in or connected to the NCU 100 of Figure 12, with a list of active (and perhaps non-active) users and their IP addresses (current if the IP address is dynamically assigned). The IP server may be maintained in the system or remotely. When a user dials a destination that has an address or number not on the system, the system can contact the server for the IP address of the destination. If the destination is active and has an IP address, the system will proceed to connect to the destination via an internet connection. If the destination does not have an IP address active, or is inactive, or is refusing connections, then the system will connect to the destination over standard circuit switched paths or telephone lines.

The server can maintain currency with the current IP address and status of the destinations according to several possible methods. First, the server can periodically query the destinations to obtain IP addresses and their status. Second, the destination upon power-up can send relevant IP address information to the server. Third, the destination, at regularly scheduled time intervals, can query the IP server to provide up-to-date information. The server may also contain up-to-date information to permit the caller to achieve the lowest possible cost calls to various destinations. Rate information can be provided by the user or by a service. Users may also enter their preferences. For example, a user may select to never make phone calls using the internet because the user objects to the sound quality or other features of internet protocol telephony.

PROGRAMMING CONFIGURATION INFORMATION

In addition to programming the system via the wireless access unit 200, the system may be programmed remotely from a computer via TCP/IP access to the internet. The user may utilize a web browser to locate a web page specified by the manufacturer of the system. The web page is located on an internet server and contains information specific to the manufacturer. At the web page, the user may enter a serial number for the system. Preferably, the serial number is located on the network control unit 100 or on each of the wireless access units 200. The web page may include a verification procedure, such as a CRC or PN algorithm to ensure that the user has entered a proper serial number. The web page may require the user to enter additional information about the system, as well.

Once the user has passed the verification procedure, a second web page is displayed by the browser. On the second web page, a questionnaire is provided regarding system configuration. The questionnaire allows the user to specify configuration information regarding the system. For instance, the questionnaire allows the user to specify a plurality of names and telephone numbers to be stored in the network control unit memory. Once the user has entered all of the desired configuration items, the user may press an END button in the second web page. The information specified in the web page is then downloaded to the manufacturer. The server will return a session identifier to the user.

The user then uses a handset to call a toll-free number specified by the manufacturer. The user is then prompted to enter a session ID. Once the session ID is entered, telephony provided by the manufacturer emits a series of tones that are recognized by the network control unit 100. The network control unit 100 then enters a configuration download mode. The manufacturer's telephony then downloads the data specified by the user.

INTERNET CONNECTIVITY

Multiple computers may be coupled to a single NCU via WAUs for

sharing of internet connectivity. For example, several computer users within a single household may desire to access the Internet via wireless computers within the home. Similarly, several users on a computer network in a small business may desire to achieve Internet connectivity. Rather than requiring multiple connections for each computer, the system of this invention allows each of the users to share a single high-speed Internet connection.

Specifically, proxy server software stored on the NCU performs the task of routing data between specific computers and the Internet. Each of the computers is coupled to the NCU via a WAU. When a computer begins an Internet session, the browser loaded on the computer transmits Internet Protocol ("IP") data to the web server. The proxy server software stored on the NCU intercepts this IP data and performs an internet address translation to determine the proper destination.

The web or other Internet server performs the request made by the transmitting computer (e.g., returning a web page). This return data is also intercepted at the NCU by the proxy server software. The software then performs a reverse Internet address translation to determine the computer for which the data is destined.

CELLULAR/PCS CONNECTIVITY

The systems of the present invention may be coupled to digital cellular telephone devices ("PCS devices") thus permitting the subscriber to receive and originate long distance telephone calls through the cellular telephone network. This option may be more financially desirable than using the local phone service provider's network. For long distance telephone service providers, local access fees would not apply.

The use of the PCS device with the communications web of this invention is illustrated in Figure 18. The PCS device 1800 may be coupled to the NCU 100 via an adapter 1905 that interfaces with the cellular phone 1800. The adapter 1805 may be analog or digital but, preferably, is digital. The digital nature of the adapter 1805 permits the direct transfer of digital audio data from the PCS device to the communications web without requiring

additional analog-to-digital conversion. If the adapter 1805 is analog, such conversion would be incorporated into the NCU 100. Alternatively, where an adapter is not available, an acoustic coupler may be used to couple the speaker and microphone of the PCS device 1800 to the NCU 100. The adapter 1805 may be coupled to the NCU 100 through a wired connection as shown or through a wireless connection, such as a WAU, or thorough applicable interfaces such as conventional air interface devices and standards including Bluetooth, Symbian and Open Service Gateway.

Figures 30 – 37 show versions of this theme. Figures 30 and 31 show wireless devices linked to the NCU 100 via physical and wireless links, respectively. Figs. 32 and 33 show wireless devices linked to a network according to the present invention via a WAU 200, and to the WAU via physical and wireless links, respectively. Figures 36 and 34 show networks, which can be wireless and/or wirelessly linked to a public network, linked to the NCU 100 via physical and wireless links, respectively. Figures 37 and 35 show networks, which can be wireless and/or wirelessly linked to a public network, linked to a network according to the present invention via a WAU 200, and to the WAU via physical and wireless links, respectively.

Once connected, the PCS device 1800 becomes a wireless cellular connection from the communications web to the PSTN. Preferably, the PCS device is used to originate and receive long distance telephone calls, thus preventing the local service provider from imposing long distance telephone service access fees. The long distance service provider routes long distance calls through the cellular connection rather than the telephone network. In addition, long distance calls originated by the subscriber by-pass the local service provider.

Alternatively, all long distance calls destined for the landline telephone numbers of the lines used in the communications web may be routed through the cellular connection. This may be accomplished by having calls to those lines forwarded to the number of the PCS device. This function may be automated by having calls automatically forwarded to the PCS device upon insertion of the adapter 1805 into the slot on the PCS device 1800. The PCS

device may be programmed to automatically dial the local service provider upon insertion of the adapter 1805.

SPEAKERPHONE/CHARGER FOR HANDSET

Figure 19 is a block diagram of a remote charger base 350 for handsets 300, according to this invention. The charger base 350 allows handsets 300 to be remotely charged and further allows the handset to function as a speakerphone while charging. The charger base 350 is located in a convenient place within the subscriber's office or home. The charger base 350 is coupled to a WAU 200 for transmitting data back to the NCU when the handset is being used as a speakerphone. Moreover, the speakerphone functionality is contained within the charger base 350, thus obviating the need for such circuitry within each of the individual handsets.

Preferably, communications between the handset 300 and the charger base 350 are all digital, but could be analog. As shown in Figure 19, digital communications, including encoded audio and supervisory data, are passed to the handset 300 via an interface 353a, 353b on each device, such as a plurality of metal contacts. The interface 353 allows power from the charger base 350 to provide a constant current to the handset 300 when the handset 300 is seated in the charger base 350. The handset alters the resistance seen by the charger base 350 using batteries in series with modulation circuitry. This modulation is seen by the charger base circuitry a small alternating current voltage superimposed upon the higher direct-current voltage supplied to the handset. This AC voltage is coupled to a microprocessor or ASIC 360 via a capacitor 363. Alternatively, two-wire uni-directional analog baseband signaling could be employed or analog modulated subcarrier could be used to carry the audio. Alternatively, additional contact points on the handset could be used to eliminate certain multiplexing tasks.

The ASIC 360 decodes digital signals generated by the handset. In addition, the ASIC 360 performs several other functions related to the charging of the handset 300 and the speakerphone functionality. Specifically,

the ASIC 360 modulates the charging current that passes from a charger base power supply 319 to the handset. This modulation may be adjusted by the speakerphone to provide specific charging voltages that allow the handset to "know" when it is seated in the speakerphone/charger rather than a conventional charging base.

When the charger base 350 and the handset 300 are acting as a speakerphone, the ASIC 360 performs the decoding, error detection, formatting, framing, synchronizing, clocking and other functions required in the digital communications between the handset squelching circuitry within the ASIC 360 reduces the electrical noise resulting from movement or vibration occurring between the charger base 350 and the handset 300 (e.g., when the handset 300 is being placed on the base 350). The ASIC 360 performs additional functions related to the speakerphone use. Specifically, the ASIC provides volume control, mute, and other audio modulation. This information is transmitted back to the handset.

Once the signals are intercepted and decoded by the ASIC 360, they are passed to a codec 352. The codec 352 decodes audio that is transmitted from the handset to the charger base 350 as serial digital communications. The codec performs these functions via separate contacts or through voltage modulation, current modulation, or a separate, modulated carrier through the interface 353. The codec 352 drives an audio amplifier 358 that, in turn drives a loudspeaker 364 for the speakerphone functionality. The codec may employ a propriety communications protocol. Rather than conventional μ-law or A-law encoding, however, the codec 352 may use a high-rate constantly variable slope delta modulation ("CVSD") scheme to reduce costs without a substantial loss of fidelity. A straight delta modulation may also be used in place of the CVSD scheme to further minimize costs.

A microphone 366 transmits ambient sounds to the charger base 350. These sounds are transmitted to a second codec 354 within the base 350. The second codec encodes the audio transmitted by the microphone 366. This encoded transmission is relayed to the handset 300 via voltage modulation, current modulation, or a separate modulated carrier through the

charging contacts.

To prevent feedback and provide for more balanced two-way communications, speakerphone audio circuitry 370 controls the gain and volumes of the respective speakerphone audio paths. This circuitry may include two gain-controlled amplifiers that are adjusted in a see-saw fashion by the louder participant in the conversation. As an alternative to this configuration, the circuitry 370 may include advanced digital signal processing ("DSP") technology. For example, adaptive, full-duplex speakerphone circuitry and adaptive, automatic room-echo cancellation circuitry may be used to eliminate unwanted audio effects normally associated with speakerphone activity. Because, as discussed above, the audio path between the handset 300 and the NCU 100 is a four-wire circuit, the speakerphone gain control or DSP functions may be distributed among the charger base 350, the NCU 100, or the NCU controller.

The charger base 350 is preferably designed such that the handset 300 may be placed face up or face down in the base. If the handset is being used by the subscriber and is placed face up on the charger base 350, the speakerphone function could be automatically activated. Similarly, if the handset were on the charger base 350 and the speakerphone were in use when the handset 300 was picked up, the call would automatically revert back to conventional handset communications. The user could, therefore, switch back and forth between speakerphone use and conventional handset use during the course of a single conversation by alternately seating the handset 300 in the charger base 350 and removing the handset from the charger base 350.

LEDs on both the handset 300 and the charger base 350 indicate the usage of the combined devices as a speakerphone. The ASIC 360 drives the LED located on the charger base 350.

The charger may also function as a conventional charging station. If the charger base acts as a conventional charging station, the speakerphone circuitry 370 may be included in a separate speaker enclosure attached to the charging station via separate contacts. The charging base 350 may also

function as a conventional cordless telephone base station. The base 350 would include the telephone line interface circuitry and radio transceiver circuitry in addition to the speakerphone and charging circuitry.

OPTICAL NETWORK UNITS

Systems of the present invention may also be used in conjunction with Optical Network Units ("ONUs") to serve as a wireless relay station between the ONU and devices in the home. ONUs provide an interface between the telephone company's fiber optic network and a subscriber's copper phone lines. Typically, an ONU services a dozen homes with as many as three to four telephone lines per home. The fiber optic network is coupled to one side of the ONU and the individual copper lines are coupled to the other side of the ONU. Since burying or digging lines into or out of the ground is often expensive, systems of the present invention provide a wireless alternative.

Figure 20 illustrates the implementation of an ONU/wireless local loop solution using the systems of the present invention. The implementation includes an ONU 230 modified to include a radio transceiver 234. The transceiver transmits and receives RF signals to and from the subscriber homes 210-216, thus replacing the copper lines normally used to connect the subscribers to the ONU. The NCU 100 is similarly modified to include an ONU-NCU transceiver 104 mounted on an exterior portion of the home. A directional antenna 107 points in the direction of the ONU 230. The transceiver 104 couples signals from the ONU to the NCU. The transceiver 104 receives the RF signals from the ONU and provides signal format conversion for compatibility with the NCU 100. The NCU then couples signals to the various wireless devices 220-226 within the home. Additional ONUs may be added to a region for improved performance. A given home may select or optimally combined signals from multiple ONUs. Reciprocally, multiple ONUs may receive a signal from a given home and the ONU or the network may optimally combine these signals. Additional ONUs increase the available bandwidth by functioning as separate wireless access points.

OPERATION

The four main component parts of systems of the present invention, as disclosed above, are the Network Control Unit 100, Wireless Access Units 200, handsets 300 and Wireless Control / Monitoring Accessories 350. While each component may contain an onboard microcontroller which governs its basic functions, the NCU 100 alone or acting in concert with external controller capacity is preferably the principal controller and manager of the entire communications web. All remote components are preferably simple, reliable and preferably of limited intelligence / functionality for reduced costs and increased modularity and so that system performance and functions are principally determined by the NCU 100. The NCU 100 may contain on-line firmware and/or software upgrade capability as discussed above. Through this capacity and the centralized intelligence architecture of the systems according to present invention, functioning of the entire system can be upgraded, new features added, software bugs repaired and hardware bugs patched, all by downloading new firmware into the new NCU 100. The majority of the NCU's computer program code is preferably maintained in flash, reprogrammable memory. Firmware in remote units are preferably implemented in ROM memory, although not necessarily.

The NCU 100 is the central part of the systems' star network topology. for the entire system, the NCU 100 selects RF channels, hop sequences if any, and spreading codes if any; it manages ID strings for the various remotes, and it performs the other functions related to network management, remote unit registration and authentication, and communications protocol management. The NCU 100 also controls the switching and interconnection of the CAB 660, and drives all the Accessory Block features of CAB 660. The following examples describe operation of two embodiments of the communications webs according to the present invention.

DISTRIBUTED INTELLIGENCE

Systems according to the present invention may contain intelligence traditionally found in the PSTN or other telecommunications networks. Such

intelligence or functionality may be located, for example, in switch 725 shown in Figure 3A. Given that residences or small offices with a number of devices may share certain characteristics in common with local exchanges, intelligence and/or functionality commonly found in more centralized telecommunications switches may be distributed out to systems of the present invention such as moved downstream to reside in the network control unit. Accordingly, switch 725 as shown in Figure 3A may contain appropriate functionality to assist or enable in signaling, routing, metering, charging and otherwise maintaining and managing the connections to user devices located in the system and coordinating with the PSTN or larger telecommunications systems and destinations thereon. Such intelligence or functionality enables more efficient and effective provision of services to the user in the same way that personal computers on a network, because they operate in a distributed architecture, more efficiently provide personalized services to the user than centralized architectures provide. Accordingly, systems according to the present invention promote a telecommunications environment which requires less centralized intelligence, command and control and therefore more flexibility with less expense and central management and control.

As an example, referring to Figure 12: A user of Handset 300 selects as a menu item the "call forwarding" option, knowing that she can be reached at another telephone number across the city for the rest of the day. Selecting the call forwarding option allows the user to enter into the handset the number of the forwarding number. When a call arrives for handset 300, Cross-connect switch / Conference Bridge / Accessory Block 660 detects the call, selects another line 640, dials the forwarding number, and puts the call through to the forwarded number. This is functionality of the sort conventionally found in telecommunications switches, and less frequently in PBX's. The flexible network control unit 100 of the present invention permits this functionality to be moved downstream to the user's equipment, thereby promoting more efficient interactivity and customization of services available to the user, and requiring fewer centralized or other resources.

VEHICLE APPLICATIONS

Access Units according to the present invention which may be similar to or the same as Wireless Access Unit 200 disclosed above can cause vehicles to be a part of systems of the present invention. Figure 21 shows such a system. Vehicle access unit 400 communicates with network control unit 100 as with other wireless access units, handsets and other components of systems of the present invention. The vehicle access unit 400 may contain or be connected to a computer 402 in order to provide appropriate processing, memory and input/output functionality to allow the vehicle to make full use of information provided via the NCU 100, and to provide appropriate information to other destinations via NCU 100. Figure 21 shows the vehicle access unit 400 and Computer 402 connected via RF link to network control unit 100 which is in turn connected to some or all of the following sources, in addition to perhaps others:

(1) Intrasystems Communications 404 which can include voice or data from other telephones, handsets, or devices connected via Wireless Access Unit or otherwise to systems according to the present invention.

(2) E-mail 406 from devices on the system controlled by the network control unit 100 or from external sources.

(3) Content 408 from the internet such as weather conditions, driving conditions, maps, directions, current news, books on tape, music and other services which can be downloaded to the vehicle in order to synchronize occupants of the vehicle with the telecommunications web.

(4) When the vehicle is in range of the system, voice and data 410 from the PSTN in real time may be supplied to the vehicle through network control unit 100.

(5) Home alarm systems, including fire, smoke, intrusion and other status information 412 may be delivered to the vehicle via the network control unit 100 within range in order to alert the occupant of conditions in the household before arrival.

(6) The NCU may contain or be connected to input/output functionality which permits the vehicle to be started via RF link using vehicle

control circuitry 414 coupled to the NCU 100, or other control of the vehicle to occur.

(7) Sources such as calendar information, address information, to do lists, and other personal information 416 may be delivered to the vehicle via NCU 100 in order to synchronize occupants of the vehicle to their data on other platforms and systems.

Additionally, the vehicle access unit 400 and/or Computer 402 may obtain information from onboard sensors for the purpose of informing occupants or controlling the vehicle. These include vehicle sensors 418 such as braking sensors, fuel injection sensors, speed sensors, radar sensors, toll booth information which may be connected to intelligence in Computer 402 or otherwise on board the vehicle which may access and automatically track, and pay, monthly or per use, toll charges thus simplifying the process for using and paying for self-toll roads. Environment Sensors 420 such as temperature sensors, humidity sensors and other sensors for the vehicle's environment may provide source information for occupant notification or vehicle control. Navigation Sensors 422 such as GPS receivers, radar proximity detection systems, inertia, speed and direction sensors, may provide additional input to vehicle access unit 400 and/or Computer 402 for occupant information purposes, reporting to devices on the system control by NCU 100 or elsewhere or vehicle control. Similarly, Vehicle Alarm System 424 may be connected to vehicle access unit 400 and/or Computer 402 to provide notification or warning in the vehicle, on the system, or beyond the system, in the event of intrusion, accident, or other events deemed appropriate for a warning.

Vehicle access unit 400 and/or Computer 402 can port information to any number of destinations on the system control by NCU 100 or to destinations beyond that system including other PSTN users, websites of businesses such as for scheduling of maintenance to conditions since by Vehicle Sensors 418, or other purposes. On board the vehicle, information may be obtained from and provided to vehicle access unit 400 and/or Computer 402 via handset 426, speaker 428, visual display 430, buttons,

keypads or other tactile devices 432, radio 434 such as via an FM link on an appropriate frequency to which the user can tune; indicators such as LEDs or LCD displays 436, keyboard 438, and/or a docking device for computers, personal assistants, palm devices or other appropriate platforms 440.

In the event that the system connected to NCU 100 includes cellular / PCS connectivity, or even if not, a docking device for cell phones 442 may be connected to vehicle access unit 400 and/or Computer 402 in order to enable the functionality shown on Figure 21 and discussed above to be accessible to the vehicle. Thus, the cell phone docking device 442 may in any number of ways connect the vehicle access unit 400 and/or Computer 402 to the network control unit 100 through a cell phone docked to a station connected to the NCU or otherwise forming a part of the system or through the system from an external PSTN or other line, or as otherwise desired.

Alternatively, docking device may be omitted in the event it is preferred that vehicle access unit 400 be linked to a system controlled by network control unit 100 via air interface such via the PSTN or otherwise using a device 443 in communication with vehicle access unit 400. Such interfaces include, for example, the Bluetooth interface, Open Service Gateway, Symbian or other air interfaces which permit interconnectivity of devices for voice and data communication. In such a case, for example, a PCS handset with appropriate air interface circuit can support a session on the PSTN while in radio communication with an appropriate air interface circuit in vehicle access unit 400 to link data, voice and other information.

The vehicle access unit 400 and/or 402, as a result of information from the system controlled by NCU 100, sources beyond, vehicle sensors, occupant input or otherwise, can control various functions and components of the vehicle such as the alarm 444, the starter / ignition functions 446, engine 448, brakes 450, steering system 452 or other components or systems 454 of the vehicle, or components of the systems mentioned above.

Figure 22 shows one specialized system which uses components of the system shown in Figure 21. Vehicle access unit 400 is connected to Computer 402 and is coupled to GPS 456 (which can be a component of

navigation sensors 422 shown in Figure 21); engine diagnostics connector 458 and engine computer 460 which can be components of vehicle sensors 418 (as shown in Figure 21). A console display 462 and automobile stereo 464 as well as any of the other devices or systems shown in Figure 21 can interact with the user. Computer 402 and Wireless Access Unit 400 are also connected to the vehicle alarm 444 in order to actuate that alarm, sense conditions from it in order to notify occupants of the vehicle, control the vehicle or report information to the system controlled by NCU 100.

Figure 23 shows another embodiment of a specialized system within the general architecture of Figure 21. Here, an RF Unit 466 is coupled to a microprocessor 468 with memory capacity 470 to interface with user input 426 - 443; diagnostic connector 458; appropriate display systems 430 and appropriate audio systems 428 for occupants of the vehicle. Expansion port 429 can provide other functionality. Again, user input 426 - 443, display systems 430 and audio systems 428 shown in Figure 23 can form or be formed of any of the functionality designated using numerals 426-443 in Figure 21.

Figure 24 shows yet another embodiment of a specific system more generally shown in Figure 21. RF Unit 466 as in Figure 23 couples the vehicle to the system controlled by NCU 100. A microprocessor 468 connected to RF unit 466 and appropriate memory 470 receives input from GPS sensor 456, user input 426 - 443, and where appropriate, from the system controlled by NCU 100 and beyond to drive a map or other appropriate display for onboard navigation or any other desired purposes. Sound is provided to occupants via an RF signal provided by RF Unit 466 or other components in the vehicle system to the automobile stereo 434. This system, as in the system of Figure 22, can employ GPS information not only for onboard navigation, but for reporting to the system controlled by NCU 100 or destinations beyond. The interactivity between such sources and microprocessor 468 coupled to GPS 456 can enhance automatic navigation of the vehicle or automatic reporting and tracking of position information.

Figures 25 and 26 show, schematically, the vehicle equipped with a vehicle access unit 400 in communication with a residential system according to the present invention through its network control unit 100 to report a break-in as detected by an appropriate sensor or alarm unit 412 which links to network control unit 100 through wireless access unit 200. Alternatively, the sensor may be part of a home alarm system whose controller is linked or otherwise connected to network control unit 100. Each of the network control unit 100, wireless access unit 200, and vehicle access unit 400, as shown in Figure 25 and disclosed above, contain appropriate RF, Modem, Logic, Control, Memory, Input / Output and where appropriate, sensor circuitry. Figure 26 shows, at a higher level, the vehicle access unit 400 in communication with the network control unit 100 which is in turn linked to an alarm system 412 for the residence. That alarm system, or other appropriate circuitry, can report warnings or other information to the vehicle, and if desired it can permit control of functions in the home, such as activation / deactivation of the alarm system 412, adjusting the thermostat, turning on the oven or dishwasher, or other desired control.

NETWORK PROXY ADDRESSABILITY

Devices forming part of systems of the present invention, such as computers, telephones, handsets, and other devices carry with them the need to support sessions on the internet, and to be connected and addressable for internet communications such as e-mail and file transfer. At the same time, each device forming part of such systems may be independently programmed to be coupled to any desired line or path inbound or outbound from such systems, or multiple of those lines or paths depending on user preferences. Furthermore, it may be desirable for each device to have its own private address, but be accessible via a public address. Figure 27 shows one architecture for providing private addressability but full connectivity and accessibility for all devices forming part of networks or systems according to the present invention. As shown in Figure 27, some or all devices are assigned private internet addresses. A network address translator or server

500, which may be a gateway which performs network address translation, is interposed between such devices and lines connecting the system to the internet. The server 500 supplants the private address with a public address, which may be that of the network control unit 100 of a system according to the present invention, or a public address for the corresponding device. Inbound communications may be handled in similar fashion, in which the public address or addresses are supplanted by the proper private address.

More particularly, according to one embodiment, functionality in the network control unit 100 can serve as an IP router, in order to route IP packets to and from the internet, and the system. The router thus has two interfaces, the internal network, and the Internet. The internal network interface forwards packets to devices on the system, and the external network is connected to the Internet. Each interface may be assigned an IP address. The internal interface can have a private IP address, which only operates as to devices on the internal network. This address need not be a valid Internet address, in which case it is unreachable from the Internet. The external interface may be assigned a valid Internet address; thus reachable from the Internet. When an internal network device, which has a private IP address, sends data to the Internet, it forward the relevant packets to the IP router functionality in the network control unit, by addressing it to the applicable internal interface address. Once the router receives the packets, it forwards them to the Internet via the external interface. Before the router can do this, it must perform a network address translation. Since the packet originated from an internal device, it has a private address that is not valid on the Internet. The router changes the source IP address, which is a private address, to its external address, which is a valid IP address, then forwards it to the Internet. When a packet is returned from the Internet, its destination address, is the network control unit's external IP address. The network control unit then changes the destination address back to the internal private address and forwards it to the device.

Figure 28 shows one manner in which addresses can be changed by the network control unit 100. The address of the internal device is

102.168.0.2 and the address of the Internet (external) device is 38.180.246.3. The address of the network control unit's external interface is 38.180.246.1. The Internet device sees the Controller, but the communication is really occurring with the internal device.

MOBILITY

Wireless networks according to the present invention can be powered for mobility in order to create a transportable mobile communications system that can be rapidly installed in any location and provide full functionality in these locations without the need for or installation of wireline connections to a telecommunications network such as the PSTN. Such a communications system is applicable in many situations. These situations include: a company with an exhibit at an industry trade-show, a construction company working a construction site, an emergency aid organization providing crucial humanitarian assistance after a disaster, or any other situation where a fully featured communications system is needed in a timely and inexpensive fashion.

Network controllers 100 in wireless networks according to the present invention are usually powered by an AC adapter with a battery backup for power out situations. However, the network controller 100 may be modified so that power can be provided from other sources, in order to create a transportable mobile communications system. Other sources of electrical power include a dedicated battery, an electric power generator, automobile cigarette adapter, solar cells, any electro-mechanical converter, or any other desired power source.

Networks according to the present invention are functional even without any POTS lines connected to the network controller 100. The wireless handsets can communicate between one another, so users can communicate to each other through the wireless handsets, in a walkie-talkie like fashion, but with greater functionality. The data jacks remain operational, so computers that are connected to the data jacks remain networked together and can share files and information.

If telecommunication network connectivity such as POTS lines are not available, connectivity with such a network can be provided through the use of an adapter that permits the connection of a cellular telephone to the network. Through the cellular telephone, networks according to the present invention can make and receive voice telephone calls, send and receive faxes, and send and receive digital data. Of course, more than one cellular telephone can be connected to such network to provide the greater flexibility that is afforded by multiple telephone lines. Additionally, the air interfaces mentioned above in the "Cellular / PCS Connectivity" section of this document may be employed for connection with the telecommunications network. Figures 30 – 37 show versions of this theme, in which wireless devices or non-HWN networks which may be connected to public networks wirelessly, are linked to networks according to the present invention via a NCU 100 or WAU 200, and to those components physically or wirelessly.

If POTS lines are available, such as in a trade-show situation, these lines can be connected to the HWN network controller. In this situation, networks according to the present invention work as if they were installed in a home or small business application.

Figure 29 is an example of a mobile network according to the present invention. In the example, the network controller 100 is connected to a power source 700. As discussed previously, the power source may be a battery, a power generator, a solar cell, automobile cigarette adapter, or other suitable device. With the network controller powered, the wireless handsets 300 can communicate among one another, and the data jacks 200 can provide data networking capability for computers. Both the cellular telephone and the POTS lines are optional. The network will operate without the presence of either the cellular telephone or any POTS lines. Without the cellular telephone or the POTS lines, the network cannot connect to the "outside" world. If a cellular telephone or the POTS lines are present, the network can connect to the "outside" world. The dashed oval demonstrates the operational range of the network.

ACCESS TO PUBLIC NETWORKS AND WIRELESS COMMUNICATIONS

Figures 30 – 37 show various architectures and techniques for linking networks according to the present invention with public networks and with other non-HWN networks.

Figure 30 is a schematic view of a network 30000 according to an embodiment of the present invention in which a wireless device 30500 is linked via a physical connection to the network control unit 30100, in order to provide one form of wireless access by the network.30000 to a public or any other network 30001. Here, device 30500 may be a cellular or PCS telephone, with or without an Internet or other data network interface such as Wireless Access Protocol, a palm computing device or palm digital assistant, or any other device adapted currently or in the future to communicate analog or digital voice and/or data information to a public network, whether circuit switched, data or hybrid. The device 30500 may mate with an adapter 30400 which has, for instance pin connections that correspond to the pin connectors on the device 30500. The adapter is, in this version, connected to the NCU 30100 via a physical link, as to a port on the NCU (and preferably, but not necessarily to a Network Interface in that NCU. Here, the device 30500 can link to its own public cell, PCS or other site, and thus provide the network 30000 access to a public switched or data or other network 30001 via the wireless link.

Figure 31 is a schematic view of a network according to an embodiment of the present invention in which a wireless device 31500 is linked via a wireless connection or air interface to the network control unit 31100, in order to provide another form of wireless access by network 31000 to another network, which can be the same as or similar to network 30001. Device 31500 can take any form that device 30500 can, and additionally has a wireless interface to link to the network control unit 31100. That wireless or air interface can take the form of a Bluetooth interface, which can be implemented in the form of Bluetooth-compatible functionality in the device 31500 and the NCU 31100. It can take the form of HWN – compatible functionality in the device 31500. It can take the form of any desired wireless

or air interface, low power or not, digital or analog, which anyone deems appropriate currently or in the future, to link device 31500 with NCU 31100. The air interface functionality in NCU 31100 may, but need not, connect to a Network Interface.

Device 31500 can if desired take the form of a personal device which can be positioned on or in the body of the user, or partially in and on the body. This embodiment of device 31500 can be implemented in integrated circuitry which includes functionality to support the radio link, render content or communication into a form to be provided to the user aurally or via visual display on implant or lens devices, and voice or other interactive functionality for receipt of commands from the user. As one example, device 31500 could take the form of a product which fits within the ear in a manner similar to a hearing aid, communicates with elements of the network over a radio link, provides content and communications to the user aurally, and receives and responds to voice or other commands from the user. As another example, device 31500 could take the form of a prosthesis or implant which partially or fully is contained within the body of the user, which communicates with elements of the network over a radio link, provides content and communications to the user internally such as transducing through bone or other body structure, and receives and responds to voice or other commands from the user. These forms of device 31500 can support the radio link through functionality such as that compatible with the Bluetooth standard, or as otherwise desired.

According to another aspect of the invention, device 31500, or any devices in communication with networks according to the present invention or components of them, could take the form of subcutaneous, transcutaneous or external (or partially both) devices positioned in, on or partially in and on the body of the user. Such devices could communicate with elements of the network control unit 100 over the network radio link, provide content and communications to the user internally such as aurally or transducing through bone or other body structure, and receive and respond to voice or other commands from the user. Power may be applied inductively, capacitatively,

directly or as otherwise desired. Instead of physical transduction of sound through bone or tissue, direct synaptic connections may be used for audio or video content. Subcutaneous or transcutaneous telephony devices with or without voice recognition control interfaces may also be used in accordance with the present invention, which operate on generally the same principles.

Figure 32 is a schematic view of a network 32000 according to an embodiment of the present invention in which a wireless device 32500 is linked via a physical connection to a wireless access unit 32200 (or a handset 32300 or any other device on the network), in order to provide one form of wireless access by the network to a network 32001, which can be the same as or similar to network 30001. Device 32500 can be similar to or the same as device 30500. It may mate with an adapter 32400, which can be part of a WAU 32200, or adapter 32400 can link to WAU 32200 by a physical connection. Device 32500 can mate with adapter 32400 in a manner similar to or the same as the manner in which device 30500 mates with adapter 30400. Here, the network 32000 obtains access to network 32001 via a WAU 32200 linked to NCU 32100, in a manner the same as or similar to the manner in which NCU's communicate with WAU"s according to the present invention.

Figure 33 is a schematic view of a network 33000 according to an embodiment of the present invention in which a wireless device 33500 is linked via a wireless connection or air interface to a wireless access unit 33200 (or a handset 33300, or any other device on the network), in order to provide one form of wireless access by the network 33000 to another network 33001. Device 33500 may be the same as or similar to device 31500, and the wireless interface between device 33500 and WAU 33200 may be implemented and operate in a manner similar to the wireless or air interface between device 31500 and NCU 31100. Here, the WAU 33200 has functionality to support the Bluetooth or other wireless or other link to the device 33500, but also functionality to support communications according to the present invention with NCU 33100. This embodiment, among other things, allows users to extend the range of Bluetooth and other low power /

short range interface compatible devices. For instance, some versions of Bluetooth compatible devices have a range of only approximately 10 – 20 feet; adding the functionality according to the present invention extends that range, and in some ways to network according to Bluetooth and similar standards, considerably.

Figure 34 is a schematic view of a network 34000 according to an embodiment of the present invention in which a non-HWN network or system 34002, which may be wireless, is linked via a wireless connection or air interface to the network control unit 34100, in order to provide one form of public network access to a public network 34001 and/or connectivity to the non-HWN network 34002 or devices in that network 34002. Devices 34005 in the non-HWN network 34002 can be linked by any suitable interface, including Bluetooth, the Home RF SWAP standard, or otherwise; one or more of the devices 34005 can also link to NCU 34100 which can have the same interface functionality implemented. In this way, network 34000 may be linked to some or all of network 34002. Additionally, one or more of the devices 34005 in network 34002 can have access to a public network 34001, wirelessly or via physical connection, and thus provide additional access by network 34000 to public network 34001. Devices 34005 can feature voice, data, voice over IP, other voice or data protocol or other functionality, or any combination of these. Any device in network 34002 can have access to any public network 34001 via the network 34000 or via a device in network 34002, if and as desired. Examples of devices 34005 include computers, printers, fax machines, personal digital assistants, pen-pads, gui devices such as WinCE devices, music machines such as mp3 devices, internet appliances, picture frames, clocks, digital cameras, portable video devices, monitoring or security devices, or otherwise; they can support data, voice, music, video, multimedia and other forms of content, either via the network 34000 or via connectivity to network 34001 by one or more of the devices 34005 in network 34002. Browsers or other graphics interfaces may be used to configure or operate any or all of devices 34005. Thus, devices in the network 34000 can access public network 34001 via NCU 34100 or network

34002, and devices in the network 34002 may be able to access public network 34001 not only by network 34000, but also by one or more devices 34005.

Figure 35 is a schematic view of a network 35000 according to an embodiment of the present invention in which a non-HWN network or system 35002, which may be wireless, is linked via a wireless connection or air interface to a wireless access unit 35200 (or handset 35300 or any other device on the network), in order to provide one form of access and/or connectivity by network 35000 to the non-HWN network 35002, or using network 35002 to public network 35001. Network 35002 and / or devices 35005 may be the same as or similar to network 34002 and / or devices 34005 respectively, and interface in the same or similar ways. WAU 35200 can operate and interface to NCU 35100 in a manner similar or identical to WAU 33200. Using this paradigm, a Bluetooth or other limited range network can be linked to a network 35000 according to the present invention, but be located a greater distance away than possible simply using the radio link supported by the network 35002. Thus, devices in the network 35000 can access public network 35001 via NCU 35100 or network 35002, and devices in the network 35002 may be able to access public network 35001 not only by network 35000, but also by one or more devices 35005.

Figure 36 is a schematic view of a network 36000 according to an embodiment of the present invention in which a non-HWN network or system 36002, which may be wireless, is linked via a physical connection to a network control unit 36100, in order to provide one form of access and/or connectivity by network 36000 to the non-HWN network 36002 or to a public network 36001. Network 36002 and / or devices 36005 can be the same as or similar to network 34001 and / or devices 34005, respectively. One or more of devices 35005 can mate with an adapter 36400 which can be the same as or similar to adapter 30400, which in turn is connected by a physical link to NCU 36100 and can interoperate with NCU 36100 and network 36000 in a manner similar or the same as adapter 30400 and NCU 30100. In this manner, for example, a Bluetooth network can be located relatively distantly

with, but interoperate with, network 36000 and thus have access to public network 36001. Similarly, network 36000 and devices on that network can have access to public network 36001 via one or more devices 36005 on network 36002, if any of such devices 36005 are linked to public network 36001.

Figure 37 is a schematic view of a network 37000 according to an embodiment of the present invention in which a non-HWN network or system 37002, which may be wireless, is linked via a physical connection to a wireless access unit 37200 (or handset 37300 or any other device on the network), in order to provide one form of access and/or connectivity by network 37000 to the non-HWN network 37002 or public network 37001 if any of devices 37005 are linked to network 37001. Devices 37005 in network 37002 may be the same as or similar to, and interoperate with each other in a manner the same as or similar to, devices 35005. One or more of devices 37005 can mate with an adapter 37400 which can be the same as or similar to adapter 32400. Adapter 37500 can operate with WAU 37200 the same as or similar to the manner in which adapter 32400 operates with respect to WAU 32200. In this manner, for example, a Bluetooth network can be located relatively distantly with, but interoperate with, network 37000 via a hybrid wireless link according to the present invention in addition to a physical link, and thus have access to public network 37001. Similarly, network 37000 and devices on that network can have access to public network 37001 via one or more devices 37005 on network 37002, if any of such devices 37005 are linked to public network 37001.

These are some illustrative examples in which networks according to the present invention can interoperate with other wireless or air interfaces or networks, whether currently existing or yet to evolve.

VIDEO, TELEVISION AND MULTIMEDIA

Figures 38A and 38B are functional block diagrams that show two broad processes for delivering television programming, audio programming, or other data intensive content via networks according to the present

invention. Such techniques preferably employ buffering through use of low cost compact hard drives, DRAM or other efficient, low cost mass storage devices. Such storage media allow buffering of significant data necessary to support audio or video programming, in an effort to address sensitivity of the wireless link to burst errors, interference, to address being occupied with other higher priority content or transmissions or to accommodate more powerful compression algorithms, among other things. Figure 38A shows as one example Network Control Unit 100 that includes a video buffer 3815 which can absorb a stream of video transmission from a video source 3805 such as a cable television provider via cable modem functionality that is included in or external to the Network Control Unit 100. The stream of content 3805 is continuous, even if the corresponding video content sent over wireless link 3820 by Network Control Unit 100 to a rendering device 3825 (which may be via a wireless access unit or other receiver 200) is not continuous; the buffer 3815 absorbs the difference and ensures supply of all content to the rendering device 3825 even in bursty or interrupted conditions. (Rendering device 3825 can be a digital or analog television monitor, recording device, or any other device or system for displaying or otherwise providing video or audio content to viewers, listeners or other users.) Figure 38B shows an architecture in which the buffer 3815 is downstream of link 3820. Buffer 3815 may be provided at each end, and in most cases will need to be if the primary buffering occurs upstream of the link 3820.

As one example, multimedia content highly compressed according to Moving Pictures Expert Group – 4 standards ("MPEG-4") can be buffered while being played at the same time. If the video stream requires 64 kbps and the wireless link 3820 accommodates 200 kbps, then for every second of video being played, 2 additional seconds can be buffered. In this way, such storage and buffering techniques provide content at the ready downstream of the link 3820 in case of interruption, interference or errors, without subjecting the network to need for other more extensive measures to ensure quality of service.

Digital or analog video can be accommodated in systems and devices of the present invention as can any other analog or digital content; by adding functionality whether embodied in hardware, software or both, at whatever layer, to the physical and other layers provided by such systems and devices, to format and distribute the content over link 3820 to devices addressed on the network or to other devices in communication with the network on other wireless or other links supported by the network. The foregoing discloses a preferred embodiment of the present invention. Various modifications, adaptations, and alternative embodiments may be made within the scope and spirit of the present invention. The invention is further defined by the following claims.

CLAIMS

What is Claimed is:

1. A communications network, comprising:

a. a network control unit, comprising a network interface linked to at least one public network, a radio transceiver adapted to send, via a first radiofrequency link, communications to a plurality of network devices and to receive communications from said network devices, and a programmable path controller for causing particular communications from said public network to be correlated to and sent to particular network devices;

b. a plurality of network devices, each network device adapted to receive communications from said network control unit via said first radiofrequency link; and at least some of said network devices adapted to (1) present an interface to the user in order to allow the user to enter commands for programming the network control unit, including programming said network control unit to cause said path controller to cause particular communications from said public network to be correlated to and sent to particular network devices, (2) communicate said commands to the network control unit for programming said path controller; and (3) communicate with each other via the network control unit without communicating over any public network; and

c. a communications device adapted to access a public network via public radiofrequency link, said device also adapted to forward communications from said network control unit to said public network via said public radiofrequency link and to receive communications from said public network via said public radiofrequency link and forward said communications to said network control unit.

2. A communications network according to claim 1 in which the communications device is linked to the network control unit physically.

3. A communications network according to claim 1 in which the communications device is linked to the network control unit at least partially using a radiofrequency link.

4. A communications network according to claim 3 in which said link between the communications device and the network control unit is not said first radiofrequency link.

5. A communications network according to claim 1 in which said network devices are adapted to communicate said commands to said network control unit via said first radiofrequency link.

6. A communications network according to claim 1 in which said communications device is linked indirectly to said network control unit, using a link between the communications device and a network device.

7. A communications network according to claim 1 which includes an adapter physically connected to the communications device and physically linked to the network control unit.

8. A communications network according to claim 1 which includes an adapter physically connected to the communications device and physically linked to a network device.

9. A communications network according to claim 8 in which the adapter forms part of a wireless access unit which in turn is linked via radiofrequency link to the network control unit.

10. A communications network according to claim 1 in which the communications device and one of the devices selected from the group consisting of the network control unit and the network devices contain radiofrequency link support circuitry to support an ancillary radiofrequency link

between said communications device and said one of the devices selected from the group consisting of the network control unit and the network devices.

11. A communications network according to claim 1 in which the network control unit is adapted to receive communications from said network devices via said first radiofrequency link.

12. A communications network according to claim 1 in which the network control unit is adapted to send communications to said network devices over a single radiofrequency link by time division multiplexing communications addressed to particular network devices onto said radio frequency link.

13. A communications network according to claim 1 in which the first radiofrequency link is a spread spectrum link.

14. A communications network according to claim 1 in which the communications device and the network control unit communicate at least partially over a local area network air interface.

15. A communications network according to claim 1 in which the communications device is a telephony device.

16. A communications network, comprising:

a. a network control unit, comprising a network interface linked to at least one public network, a radio transceiver adapted to send, via a first radiofrequency link, communications to a plurality of network devices and to receive communications from said network devices via said first radiofrequency link, and a programmable path controller for causing particular communications from said public network to be correlated to and sent to particular network devices;

b. a plurality of network devices, each network device adapted to receive communications from said network control unit via said first

radiofrequency link; and at least some of said network devices adapted to (1) present an interface to the user in order to allow the user to enter commands for programming the network control unit, including programming said network control unit to cause said path controller to cause particular communications from said public network to be correlated to and sent to particular network devices, (2) communicate said commands to the network control for programming said path controller via said first radiofrequency link; and (3) communicate with each other via the network control unit without communicating over any public network; and

c. a communications device adapted to access a public network via a second radiofrequency link, said device also adapted to receive communications from said network control unit via a third radiofrequency link and forward said communications to said public network via said second radiofrequency link and to receive communications from said public network via said second radiofrequency link and forward said communications to said network control unit via said third radiofrequency link.

17. A communications network according to claim 16 in which the third radiofrequency link is between the network control unit and said communications device.

18. A communications network according to claim 16 in which the third radiofrequency link is between a network device and the communications device.

19. A communications network according to claim 16 in which the third radiofrequency link is supported by circuitry in the communications device and one of the devices selected from the group consisting of the network control unit and the network devices.

20. A communications network according to claim 16 in which the third radiofrequency link is supported by a local area network air interface.

21. A communications network, comprising:

a. a first network, comprising:

(1) a first network control unit, comprising a network interface linked to at least one public network, a radio transceiver adapted to send, via a first radiofrequency link, communications to a plurality of network devices and to receive communications from said first network devices, and a programmable path controller for causing particular communications from said public network to be correlated to and sent to particular first network devices; and

(2) a plurality of first network devices, each first network device adapted to receive communications from said network control unit via said first radiofrequency link; and at least some of said first network devices adapted to (i) present an interface to the user in order to allow the user to enter commands for programming the network control unit, including programming said network control unit to cause said path controller to cause particular communications from said public network to be correlated to and sent to particular first network devices, (ii) communicate said commands to the network control unit for programming said path controller; and (iii) communicate with each other via the network control unit without communicating over any public network; and

b. a second network comprising a plurality of second network devices, at least one of said devices adapted to communicate with said network control unit, in order to send communications to said network control unit and to receive communications from said network control unit.

22. A communications network according to claim 21 in which the second network devices are networked using an air interface.

23. A communications network according to claim 21 in which said at least one of the second network devices communicates with said network control unit directly.

24. A communications network according to claim 21 in which said at least one of the second network devices communicates with said network control unit by communicating with a first network device, which first network device sends said communications to said network control unit.

25. A communications network according to claim 21 in which said at least one of the second network devices communicates with one of the devices selected from the group of the network control unit and the first network devices via a physical link.

26. A communications network according to claim 21 in which said at least one of the second network devices communicates with one of the devices selected from the group of the network control unit and the first network devices via a non-physical link.

27. A communications network according to claim 21 in which said at least one of the second network devices and one of the devices selected from the group consisting of the network control unit and the first network devices contain ancillary radiofrequency link support circuitry to support a ancillary radiofrequency link between said at least one second network device and said one of the devices selected from the group consisting of the network control unit and the first network devices.

28. A communications network according to claim 21 in which at least one of the second network devices is linked to a public network, and at least one first network device is in communication with said public network via said second network.

29. A communications network according to claim 21 in which at least one first network device is in communication with at least one second network device.

30. A communications network according to claim 21 in which at least one second network device is in communication with the public network via said first network.

31. A communications network, comprising:

a. a first network, comprising:

(1) a first network control unit, comprising a network interface linked to at least one public network, a radio transceiver adapted to send, via a first radiofrequency link, communications to a plurality of network devices and to receive communications from said first network devices via said first radiofrequency link, and a programmable path controller for causing particular communications from said public network to be correlated to and sent to particular first network devices; and

(2) a plurality of first network devices, each first network device adapted to receive communications from and send communications to said network control unit via said first radiofrequency link; and at least some of said first network devices adapted to (i) present an interface to the user in order to allow the user to enter commands for programming the network control unit, including programming said network control unit to cause said path controller to cause particular communications from said public network to be correlated to and sent to particular first network devices, (ii) communicate said commands to the network control unit for programming said path controller via said first radiofrequency link; and (iii) communicate with each other via the network control unit without communicating over any public network; and

b. a second network comprising a plurality of second network devices, at least one of said second network devices adapted to communicate with said network control unit over via a second radiofrequency link, said at least one of said second network devices also adapted to communicate with other second network devices.

32. A communications network according to claim 31 in which the second radiofrequency link is a local area network air interface and said at least one of said second network devices is also adapted to communicate with other second network devices via said air interface.

33. A communications network according to claim 31 in which the network control unit of the first network and at least one second network device contain circuitry to support said second radiofrequency link.

34. A communications network according to claim 31 in which at least one of the devices in the second network is in communication with a public network.

35. A communications network according to claim 31 in which at least one of the devices in the second network is in communication with a public network, and at least one first network device is in communication with said public network via said second network.

36. A communications network according to claim 31 in which at least one of the devices in the second network is in communication with a public network via said first network.

37. A communications network according to claim 31 in which at least one of the devices in the second network is in communication with one of the devices in said first network.

38. A communications network, comprising:

a. a first network, comprising:

(1) a first network control unit, comprising a network interface linked to at least one public network, a radio transceiver adapted to send, via a first radiofrequency link, communications to a plurality of network devices and to receive communications from said first network devices via said first

radiofrequency link, and a programmable path controller for causing particular communications from said public network to be correlated to and sent to particular first network devices; and

(2) a plurality of first network devices, each first network device adapted to receive communications from and send communications to said network control unit via said first radiofrequency link; and at least some of said first network devices adapted to (i) present an interface to the user in order to allow the user to enter commands for programming the network control unit, including programming said network control unit to cause said path controller to cause particular communications from said public network to be correlated to and sent to particular first network devices, (ii) communicate said commands to the network control unit for programming said path controller via said first radiofrequency link; and (iii) communicate with each other via the network control unit without communicating over any public network; and

b. a second network comprising a plurality of second network devices, at least one of said second network devices adapted to communicate with a first network device over via a second radiofrequency link, said at least one of said second network devices also adapted to communicate with other second network devices.

39. A communications network according to claim 38 in which the second radiofrequency link is a local area network air interface and said at least one of said second network devices is also adapted to communicate with other second network devices via said air interface.

40. A communications network according to claim 38 in which said first network device and said at least one second network device contain circuitry to support said second radiofrequency link.

41. A communications network according to claim 38 in which at least one of the devices in the second network is in communication with a public network.

42. A communications network according to claim 38 in which at least one of the devices in the second network is in communication with a public network, and at least one first network device is in communication with said public network via said second network.

43. A communications network according to claim 38 in which at least one of the devices in the second network is in communication with a public network via said first network.

44. A communications network according to claim 38 in which at least one of the devices in the second network is in communication with one of the devices in the first network.

45. A communications network according to claim 38 in which said at least one second network device adapted to communicate with said first network device is adapted to communicate with said network control unit, via said first radiofrequency link and said second radiofrequency link using said first network device.

46. A communications network, comprising:

a. a network control unit, comprising a network interface linked to at least one public network, a radio transceiver adapted to send, via a first radiofrequency link, communications to a plurality of network devices and to receive communications from said network devices via said first radiofrequency link, and a programmable path controller for causing particular communications from said public network to be correlated to and sent to particular network devices; and

b. a plurality of network devices, each network device adapted to receive communications from and send communications to said network control unit via said first radiofrequency link; and at least some of said network devices adapted to (i) present an interface to the user in order to allow the user to enter commands for programming the network control unit, including programming said network control unit to cause said path controller to cause particular communications from said public network to be correlated to and sent to particular network devices, (ii) communicate said commands to the network control unit for programming said path controller via said first radiofrequency link; and (iii) communicate with each other via the network control unit without communicating over any public network; and

c. wherein at least one device selected from the group consisting of said network control unit and said network devices includes circuitry adapted to support a second radiofrequency link, said second radiofrequency link capable of linking said network to a device not in communication with said network via said first radiofrequency link.

47. A communications network according to claim 46 in which said second radiofrequency link is a local area network air interface.

48. A communications network according to claim 46 in which said second radiofrequency link provides said network access to a public network.

49. A communications network according to claim 46 in which said device not in communication with the network via said first radiofrequency link has access to a public network via said second radiofrequency link.

50. A communications network according to claim 46 in which the network control unit contains said circuitry adapted to support said second radiofrequency link.

51. A communications network according to claim 46 in which a network device contains said circuitry adapted to support said second radiofrequency link.

FIG. 1

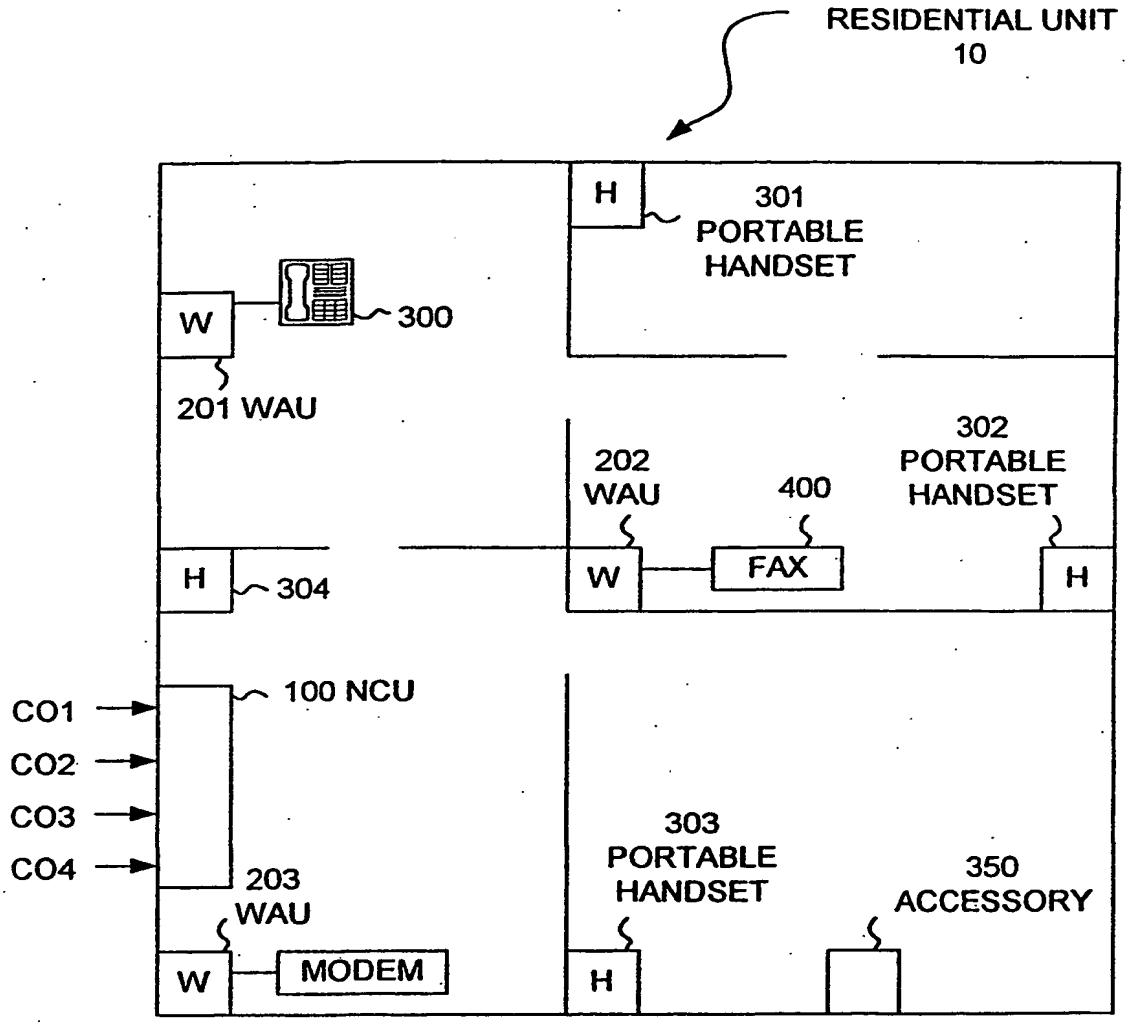
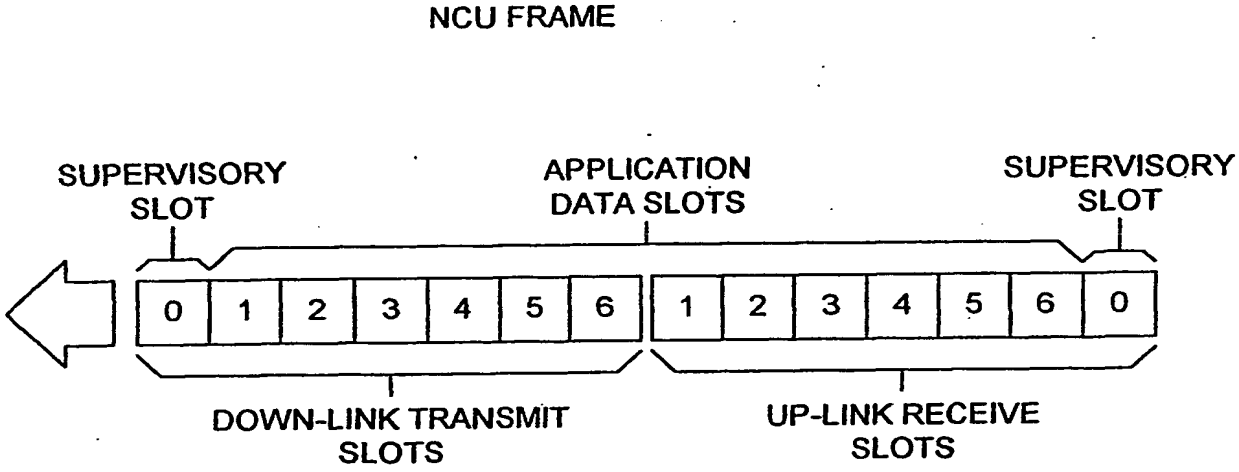

RESIDENTIAL UNIT
10
H
301
PORTABLE
HANDSET
W
300
201 WAU
202
WAU
400
302
PORTABLE
HANDSET
H
304
W
FAX
H
CO1
CO2
CO3
CO4
100 NCU
303
PORTABLE
HANDSET
350
ACCESSORY
203
WAU
W
MODEM
H

FIG. 2


NCU FRAME
SUPERVISORY SLOT
APPLICATION DATA SLOTS
SUPERVISORY SLOT
0 1 2 3 4 5 6 1 2 3 4 5 6 0
DOWN-LINK TRANSMIT SLOTS
UP-LINK RECEIVE SLOTS

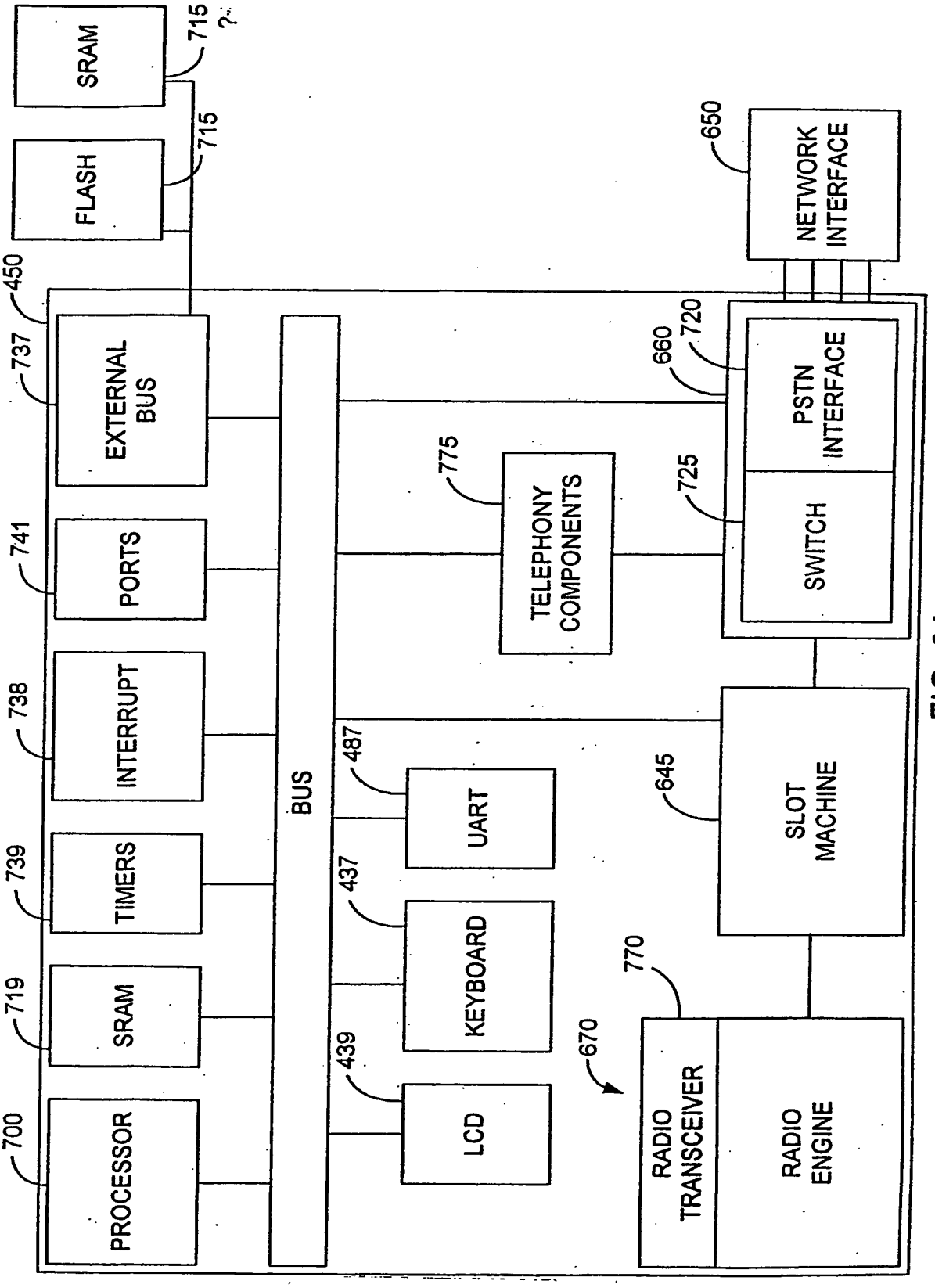

SRAM
715
FLASH
715
650
NETWORK INTERFACE
450
737
EXTERNAL BUS
660
720
PSTN INTERFACE
775
TELEPHONY COMPONENTS
725
SWITCH
741
PORTS
738
INTERRUPT
BUS
487
UART
645
SLOT MACHINE
739
TIMERS
437
KEYBOARD
719
SRAM
770
670
439
LCD
700
PROCESSOR
RADIO TRANSCEIVER
RADIO ENGINE

FIG. 3A

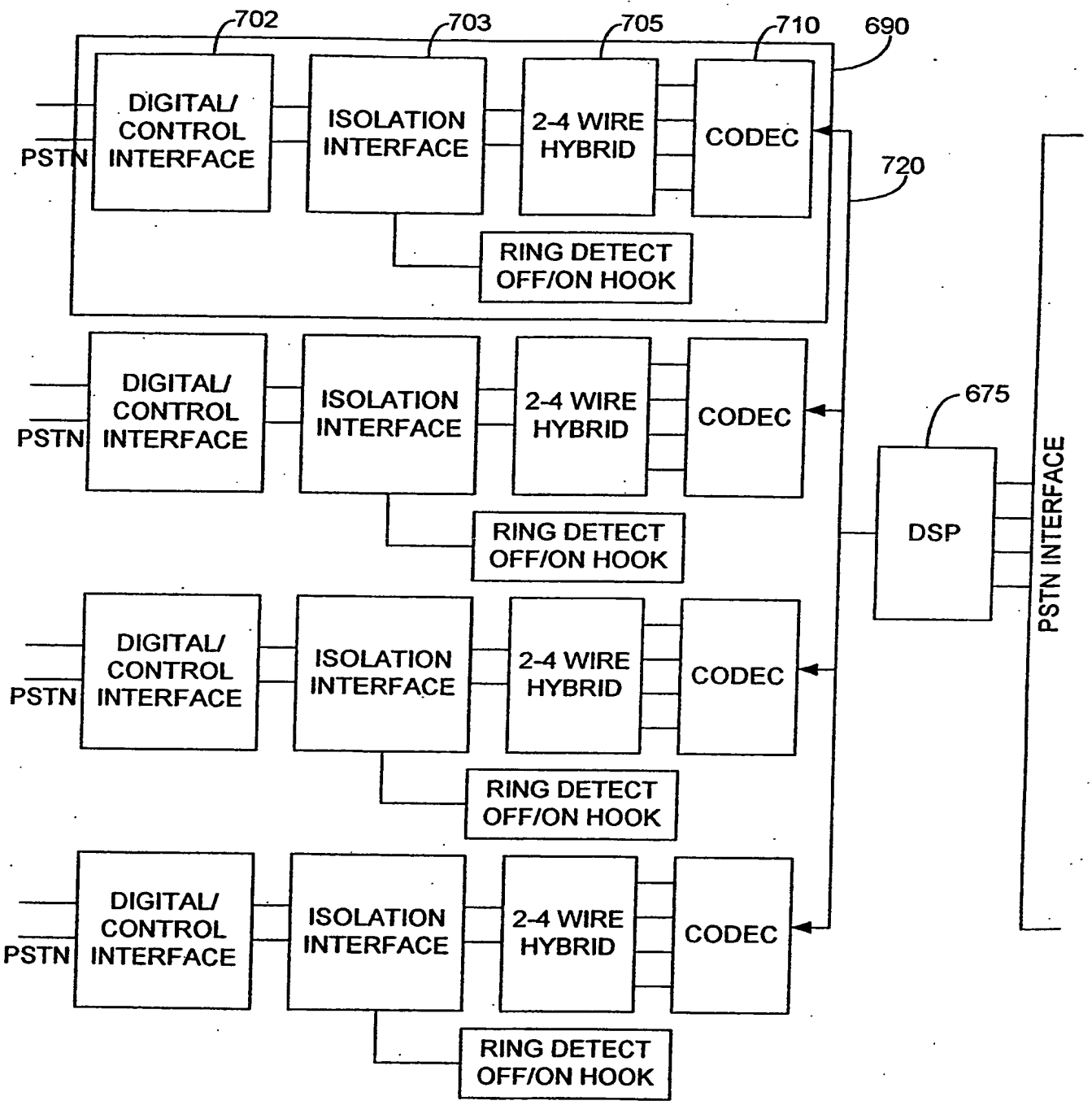

702
703
705
710
690
720
675
DIGITAL/ CONTROL INTERFACE
ISOLATION INTERFACE
2-4 WIRE HYBRID
CODEC
PSTN
RING DETECT OFF/ON HOOK
DSP
PSTN INTERFACE

FIG. 3B

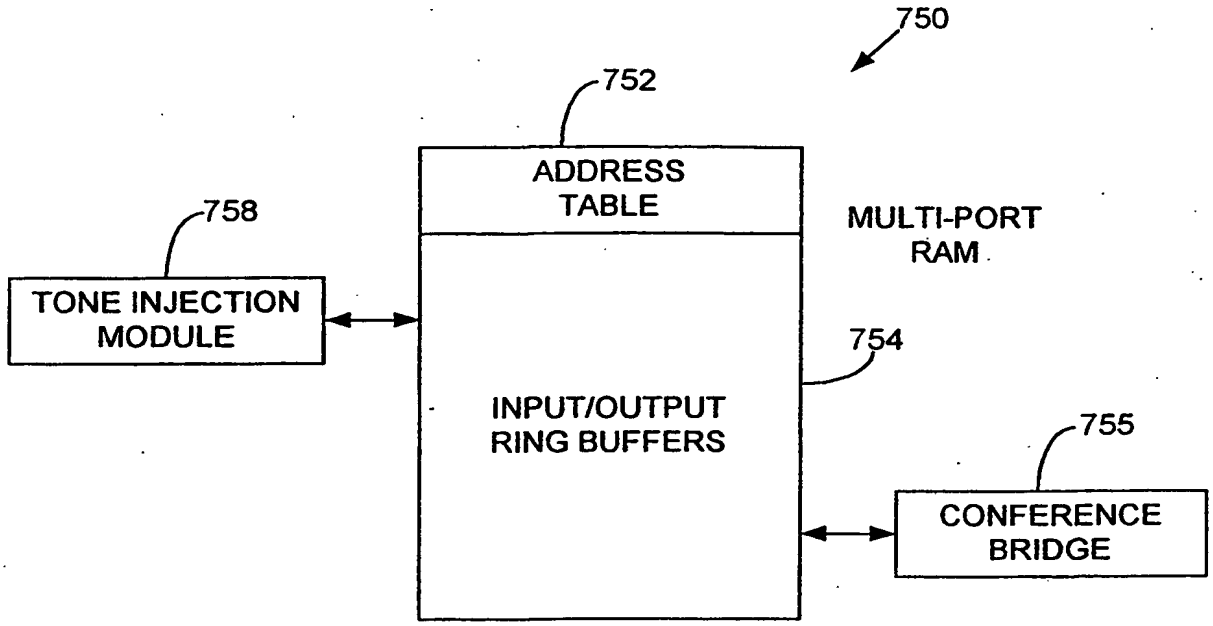

750
752
ADDRESS TABLE
MULTI-PORT RAM
758
TONE INJECTION MODULE
754
INPUT/OUTPUT RING BUFFERS
755
CONFERENCE BRIDGE

FIG. 3C

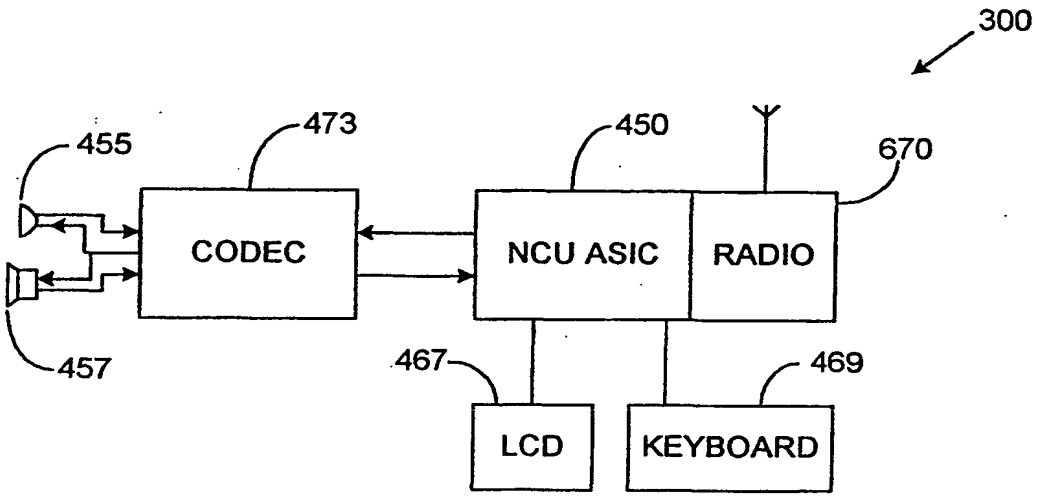

300
455
473
450
670
CODEC
NCU ASIC
RADIO
457
467
469
LCD
KEYBOARD

FIG. 4

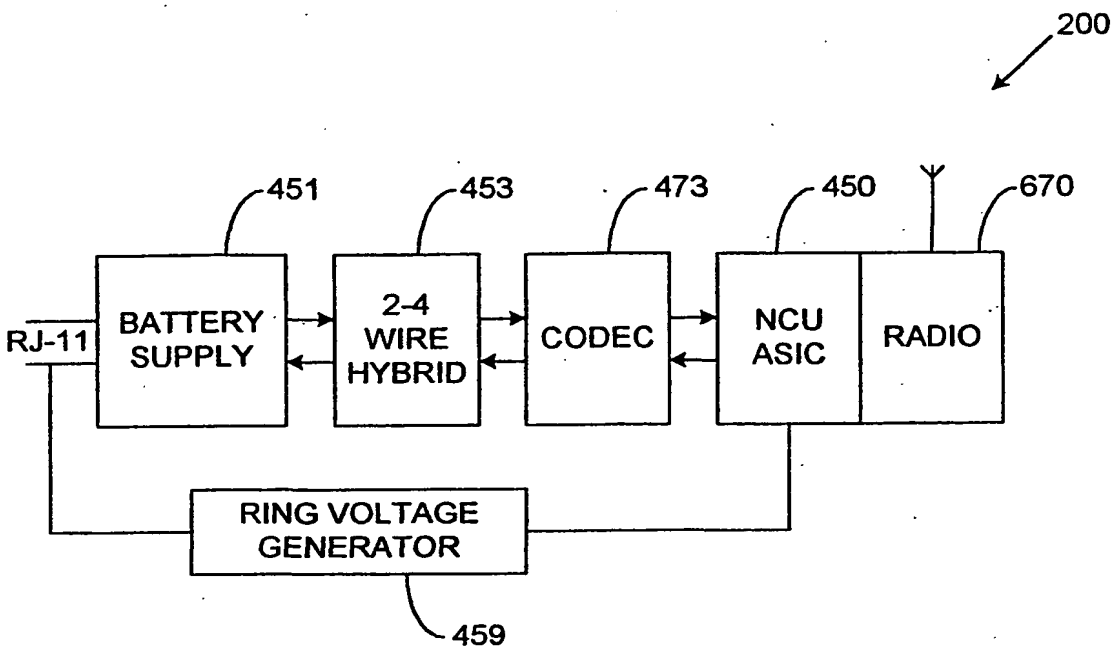

200
451
453
473
450
670
RJ-11
BATTERY SUPPLY
2-4 WIRE HYBRID
CODEC
NCU ASIC
RADIO
RING VOLTAGE GENERATOR
459

FIG. 5

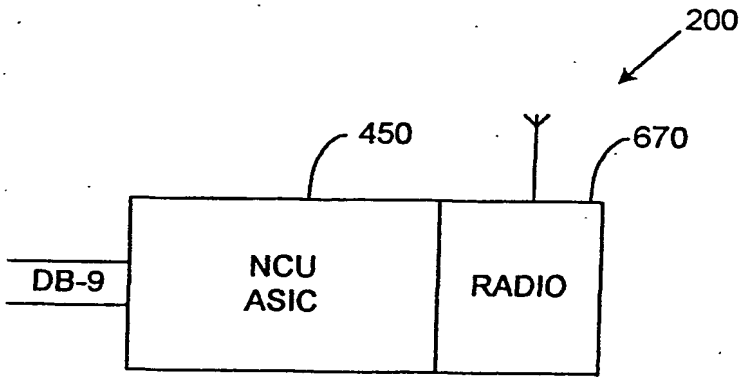


FIG. 6

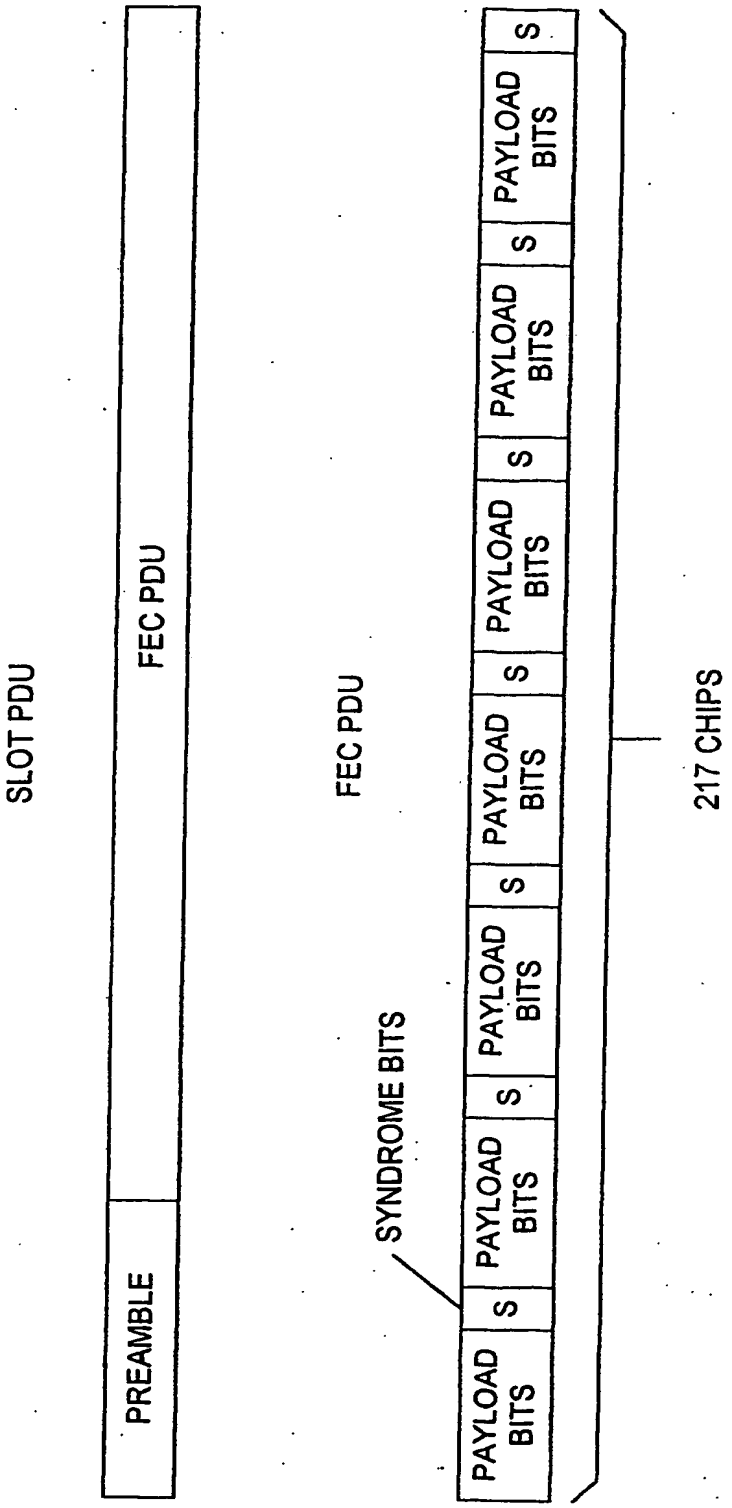

SLOT PDU
PREAMBLE
FEC PDU
FEC PDU
SYNDROME BITS
PAYLOAD BITS
S
PAYLOAD BITS
S
PAYLOAD BITS
S
PAYLOAD BITS
S
PAYLOAD BITS
S
PAYLOAD BITS
S
PAYLOAD BITS
S
217 CHIPS

FIG. 7

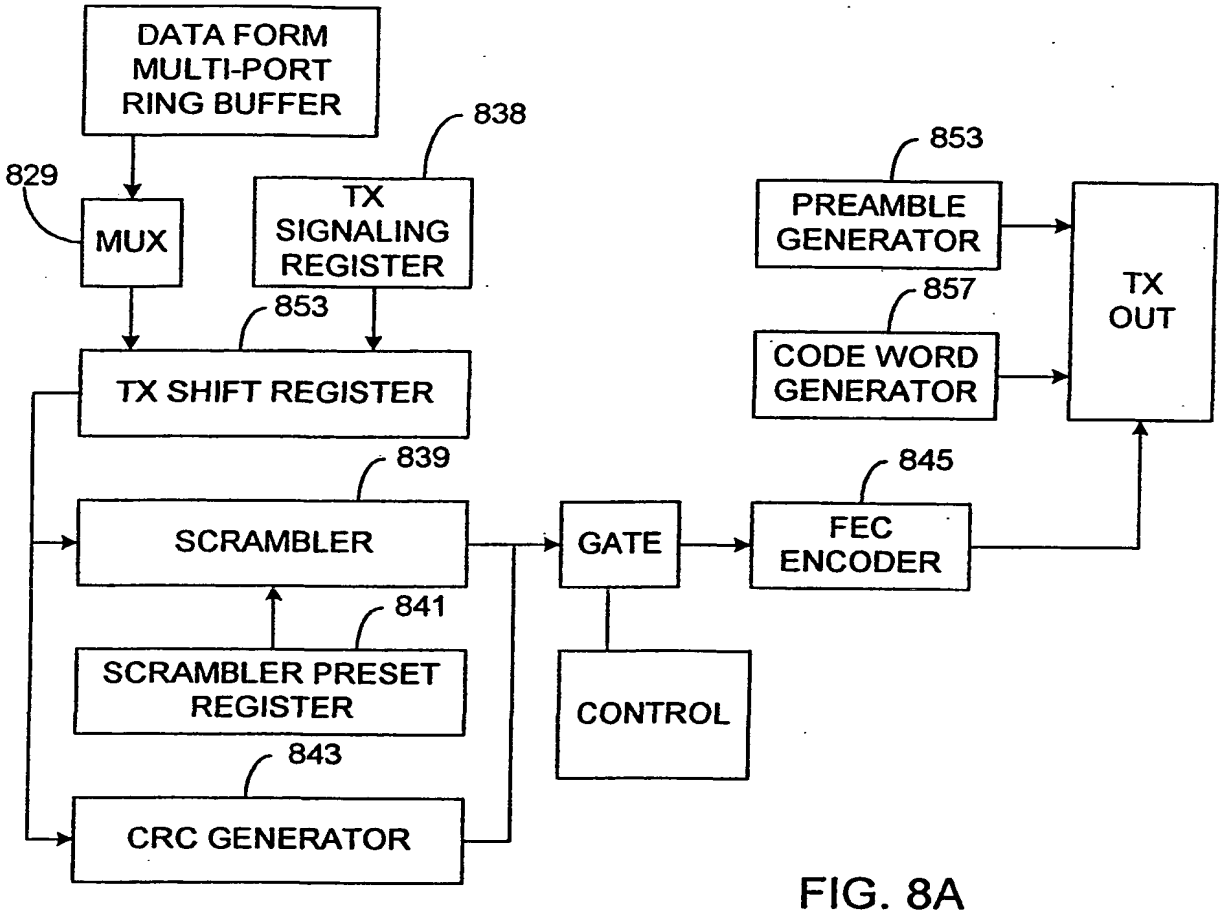

DATA FORM MULTI-PORT RING BUFFER
838
829
MUX
TX SIGNALING REGISTER
853
TX SHIFT REGISTER
839
SCRAMBLER
841
SCRAMBLER PRESET REGISTER
843
CRC GENERATOR
GATE
CONTROL
853
PREAMBLE GENERATOR
857
CODE WORD GENERATOR
845
FEC ENCODER
TX OUT

FIG. 8A

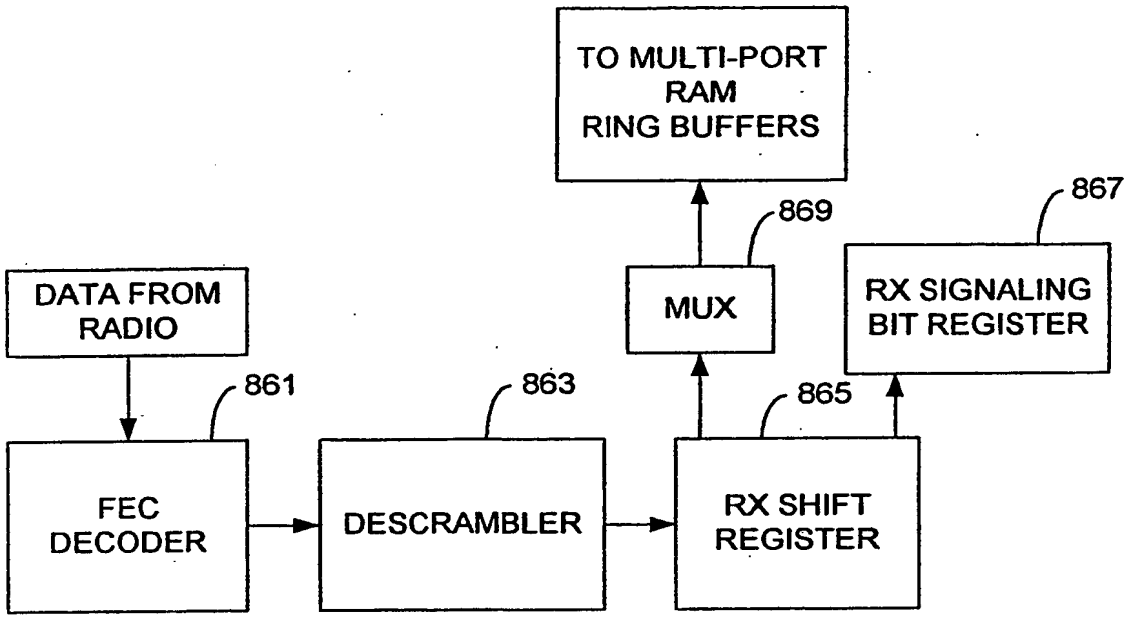

TO MULTI-PORT RAM RING BUFFERS
867
869
DATA FROM RADIO
MUX
RX SIGNALING BIT REGISTER
861
863
865
FEC DECODER
DESCRAMBLER
RX SHIFT REGISTER

FIG. 8B

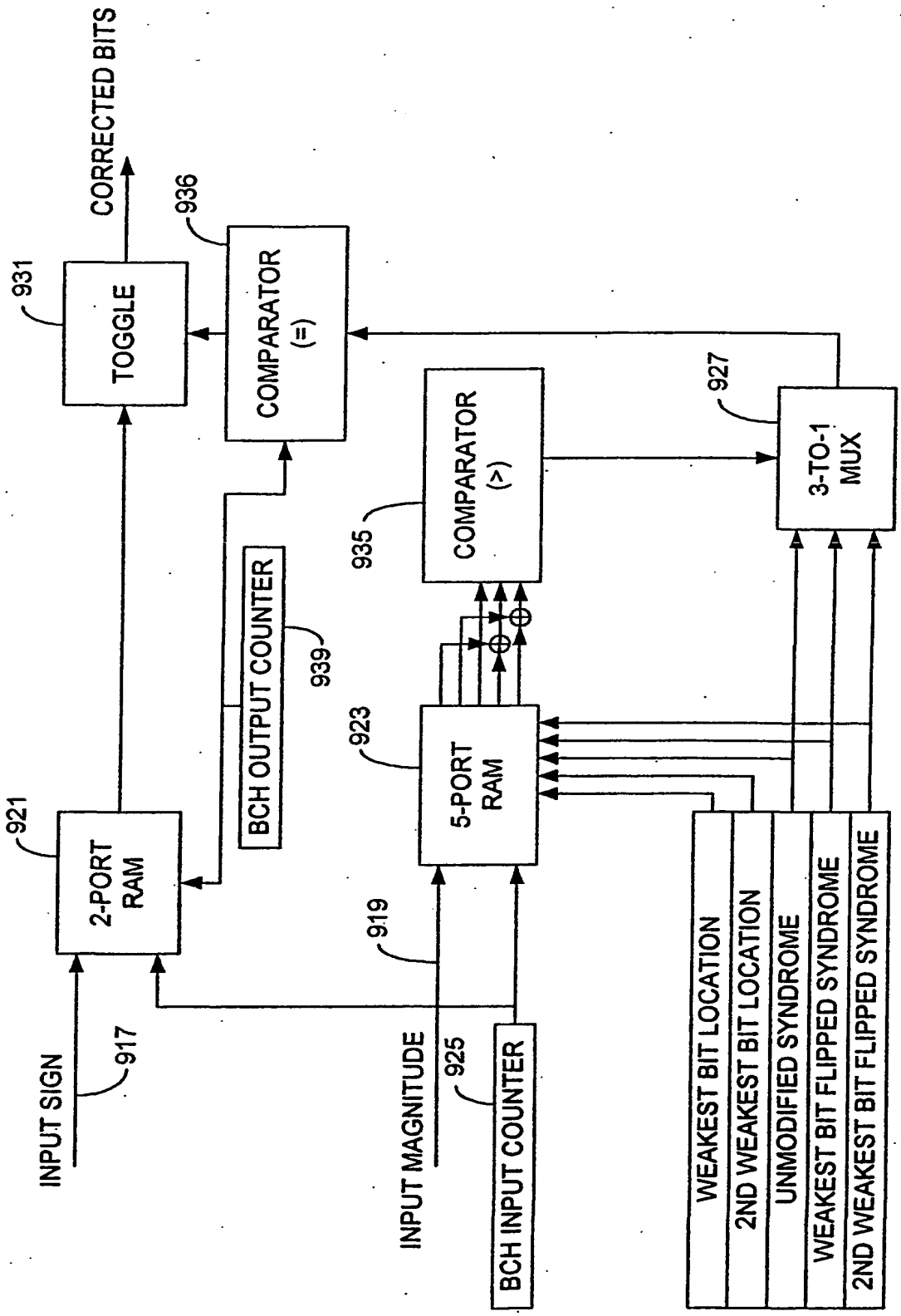

CORRECTED BITS
936
931
TOGGLE
COMPARATOR (=)
927
3-TO-1 MUX
COMPARATOR (>)
935
BCH OUTPUT COUNTER
939
923
5-PORT RAM
921
2-PORT RAM
919
917
INPUT SIGN
INPUT MAGNITUDE
925
BCH INPUT COUNTER
WEAKEST BIT LOCATION
2ND WEAKEST BIT LOCATION
UNMODIFIED SYNDROME
WEAKEST BIT FLIPPED SYNDROME
2ND WEAKEST BIT FLIPPED SYNDROME

FIG. 9

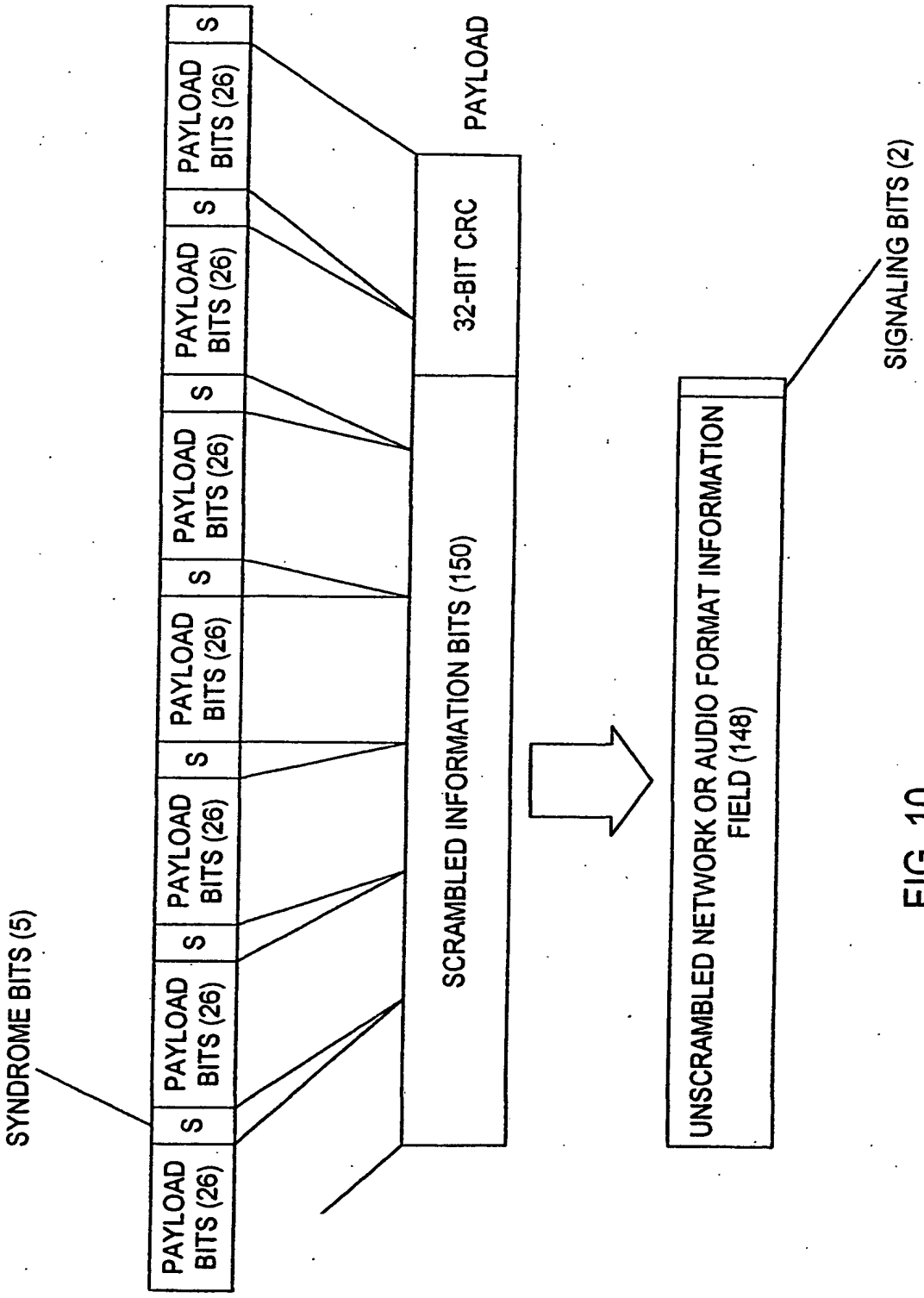
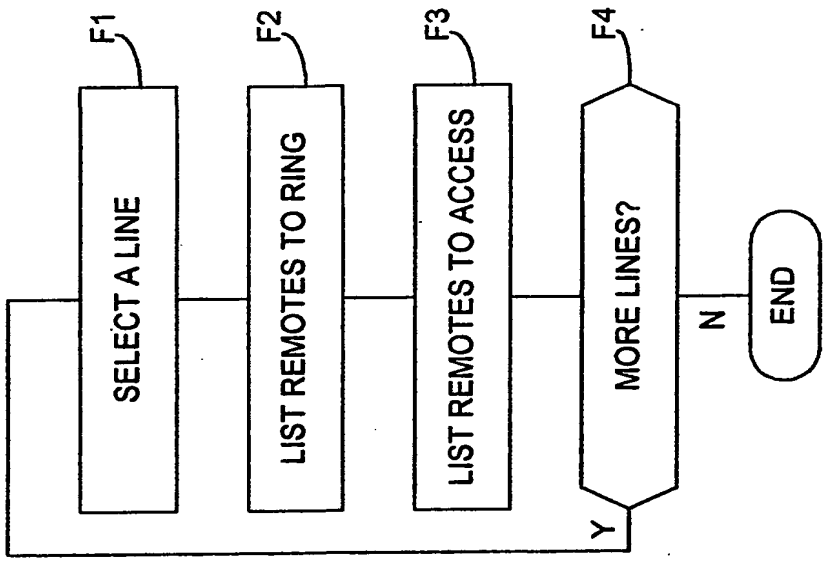

PAYLOAD BITS (26)
S
PAYLOAD BITS (26)
S
PAYLOAD BITS (26)
S
PAYLOAD BITS (26)
S
PAYLOAD BITS (26)
S
PAYLOAD BITS (26)
S
PAYLOAD BITS (26)
SYNDROME BITS (5)
PAYLOAD
32-BIT CRC
SCRAMBLED INFORMATION BITS (150)
UNSCRAMBLED NETWORK OR AUDIO FORMAT INFORMATION FIELD (148)
SIGNALING BITS (2)

FIG. 10

FIG. 11B

LINE	RING	ACCESS
1	201, 203 301-304	201, 203 301-304
2	201, 203 301-304	201, 203 301-304
3	301	301
4	202	202

FIG. 11A



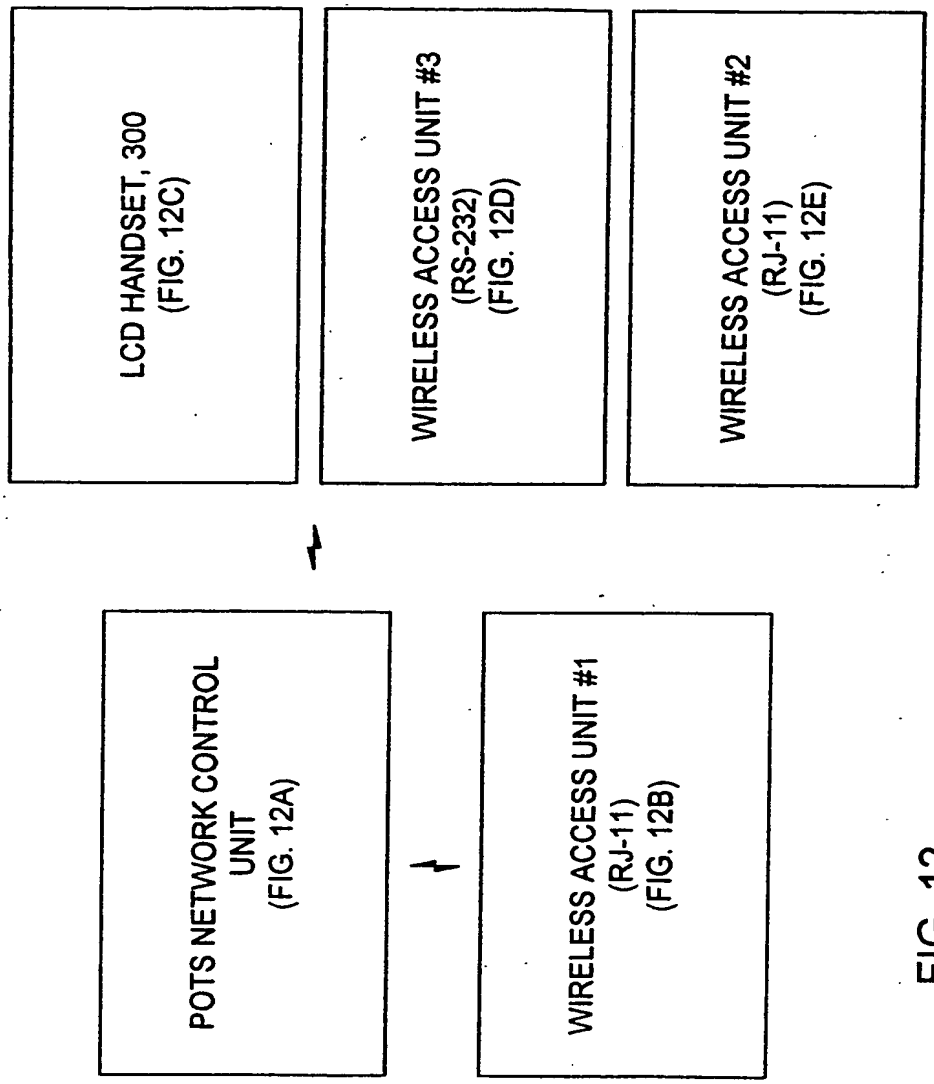


FIG. 12
POTS HOME PERSONAL COMMUNICATIONS SYSTEM

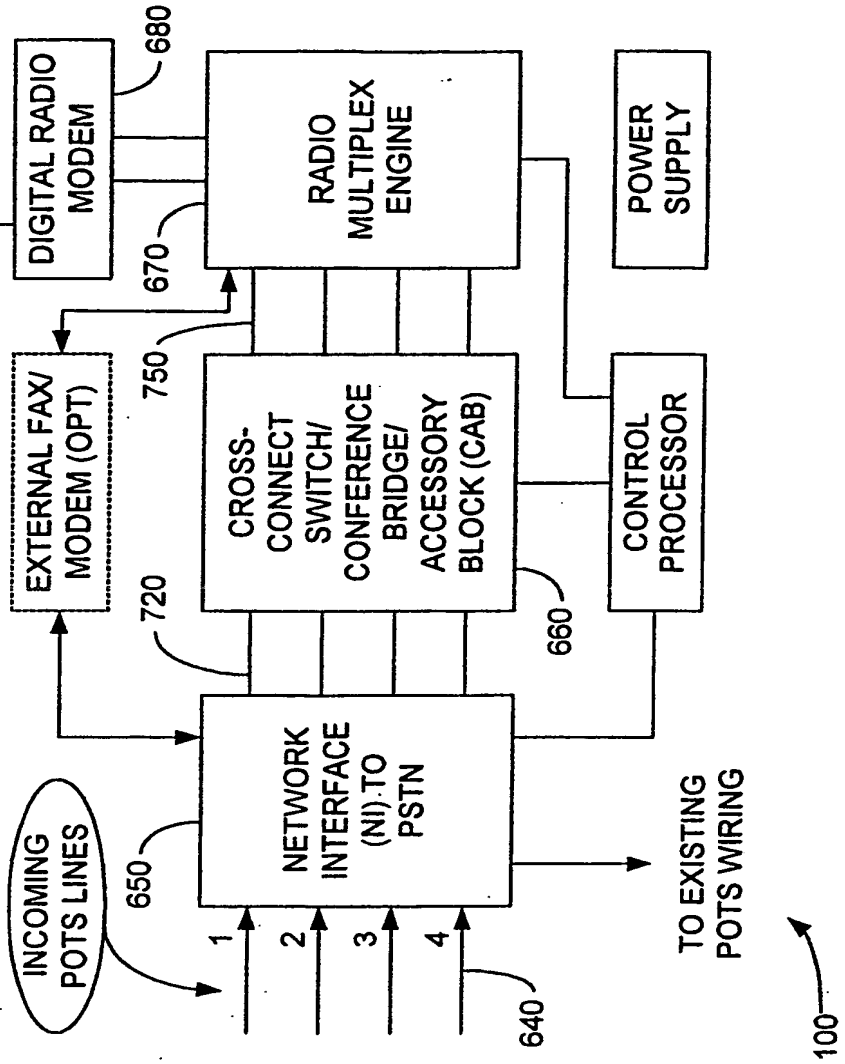


FIG. 12A

POTS NETWORK CONTROL UNIT

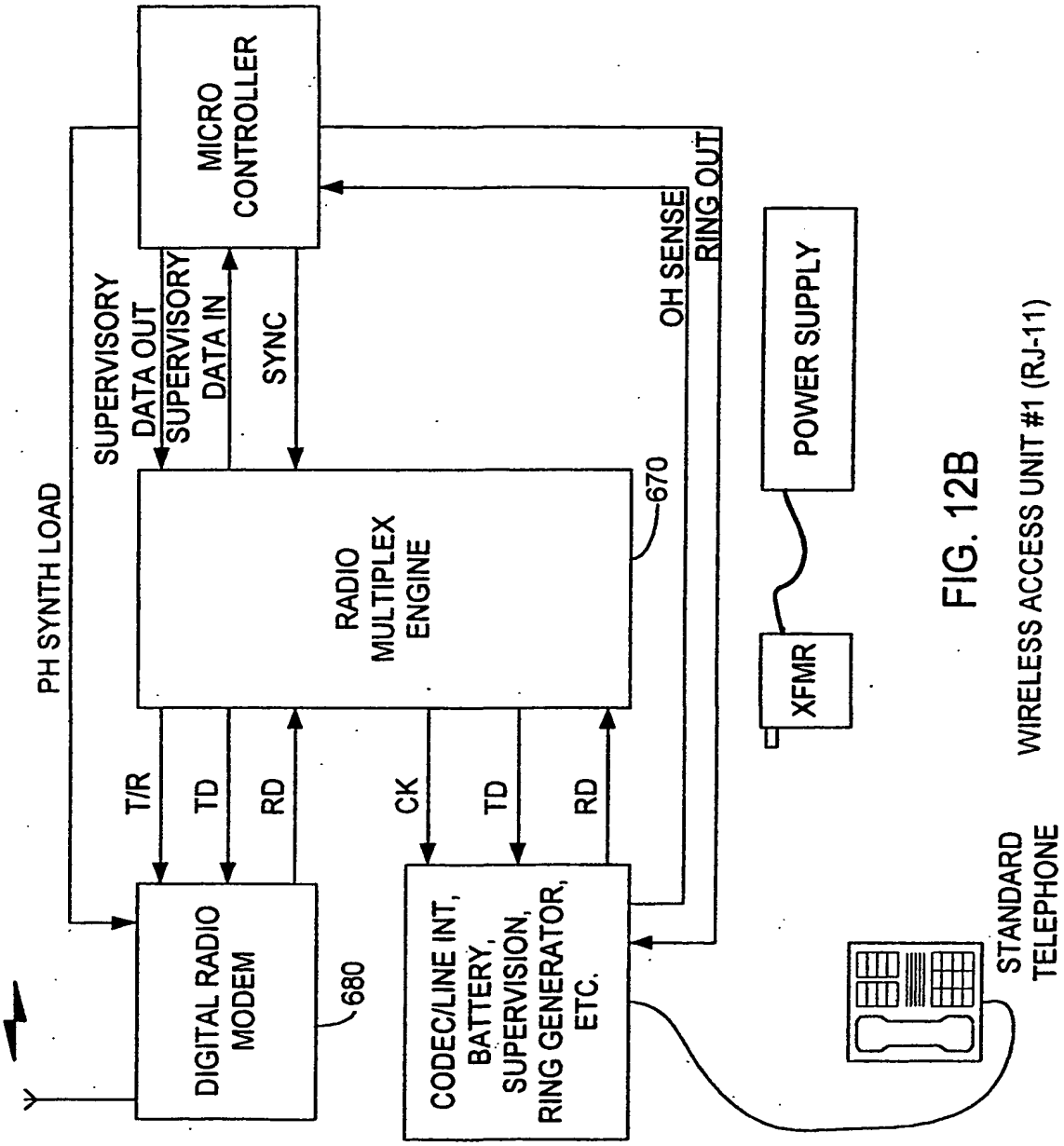


FIG. 12B

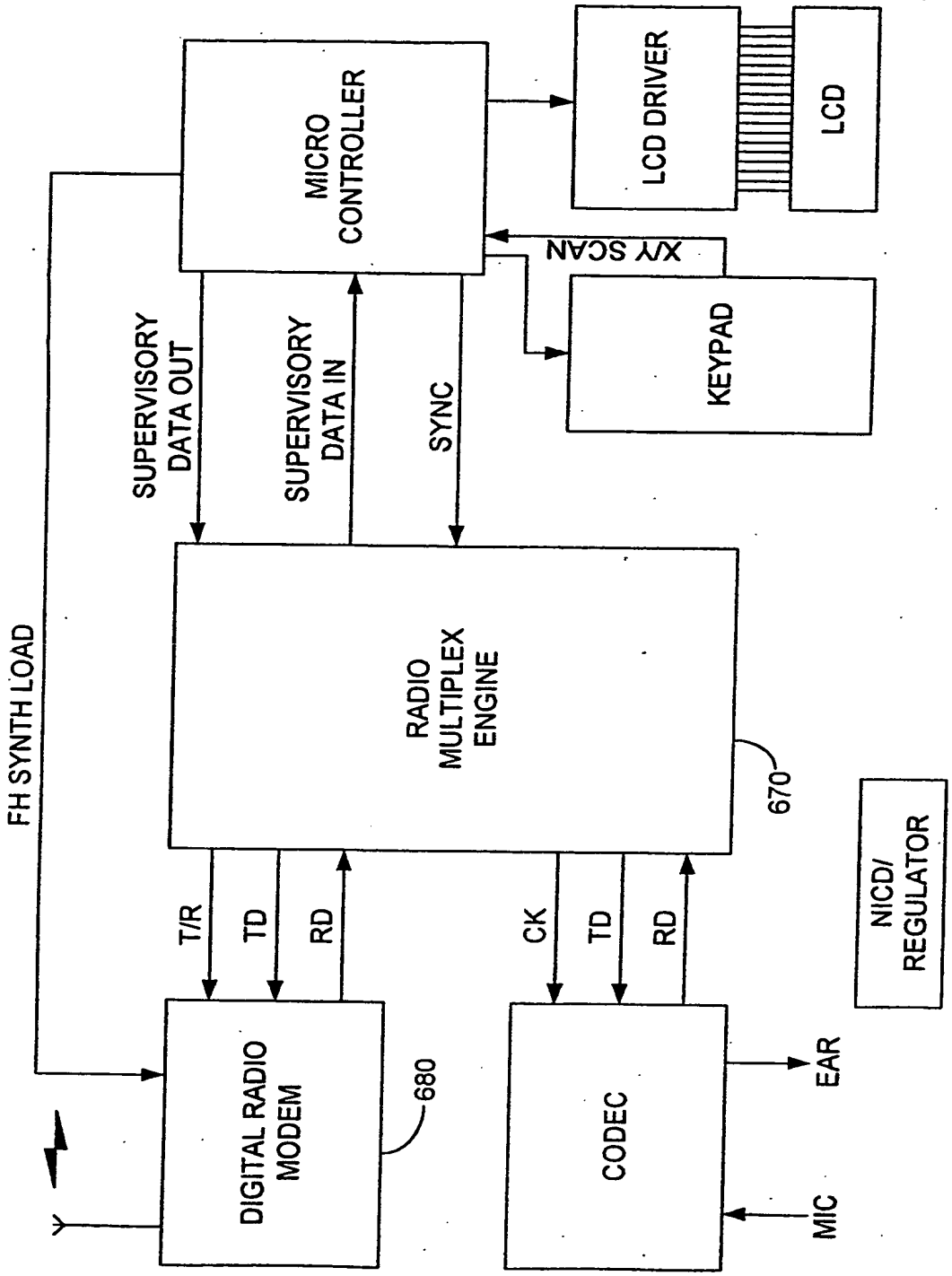


FIG. 12C

LCD HANDSET, 300

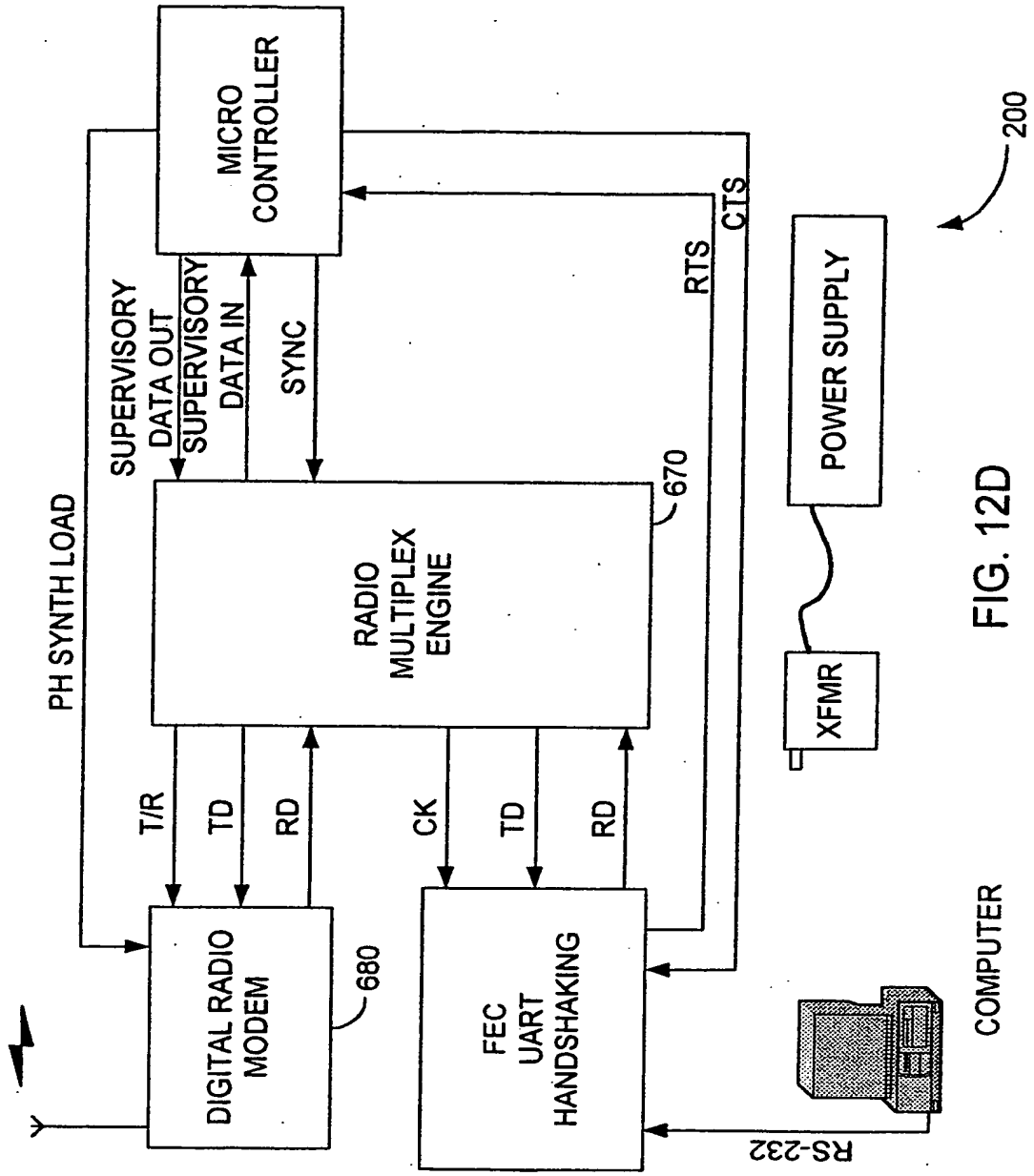


FIG. 12D
WIRELESS ACCESS UNIT #3 (RS-232)

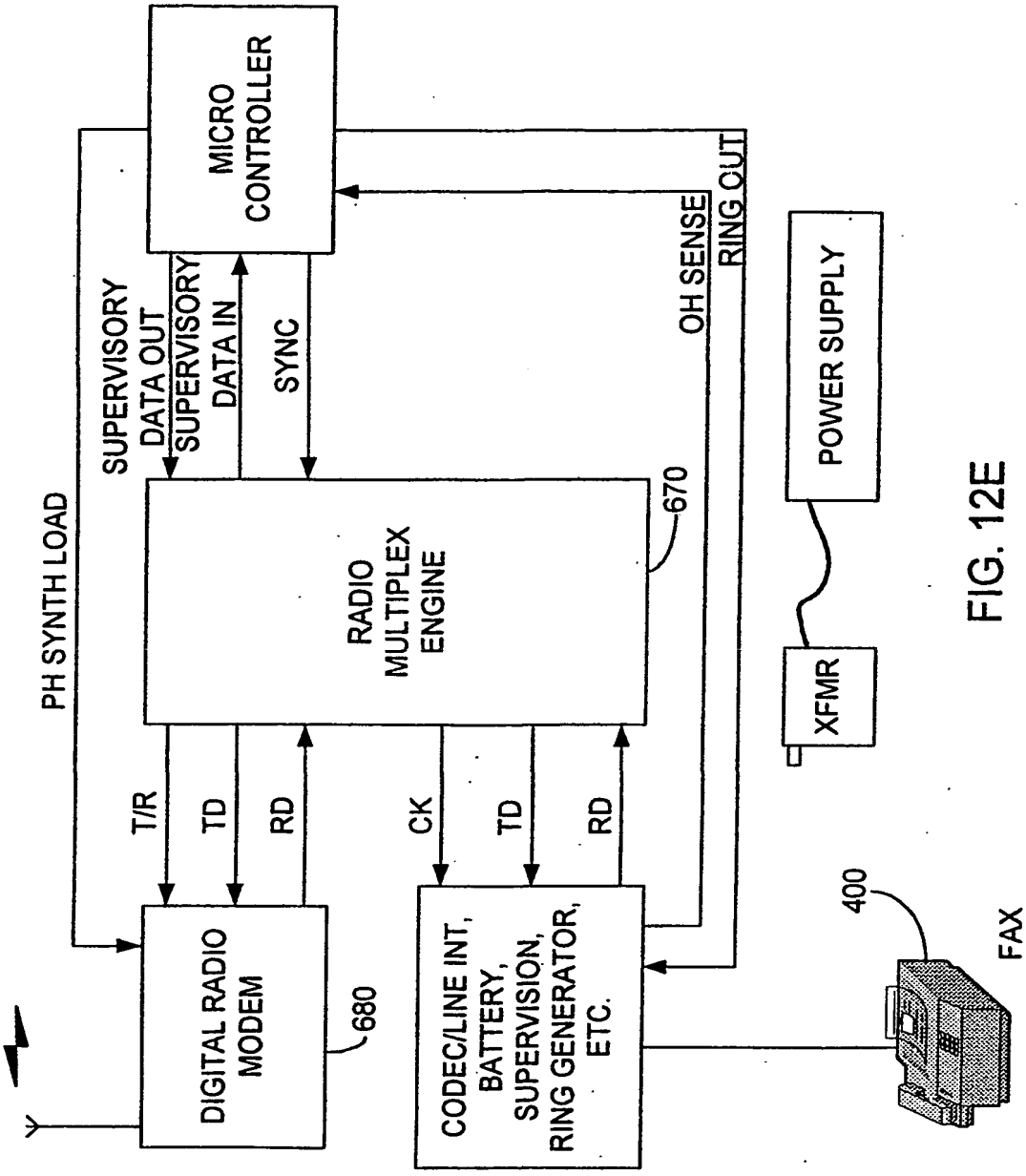


FIG. 12E

WIRELESS ACCESS UNIT #2 (RJ-11)

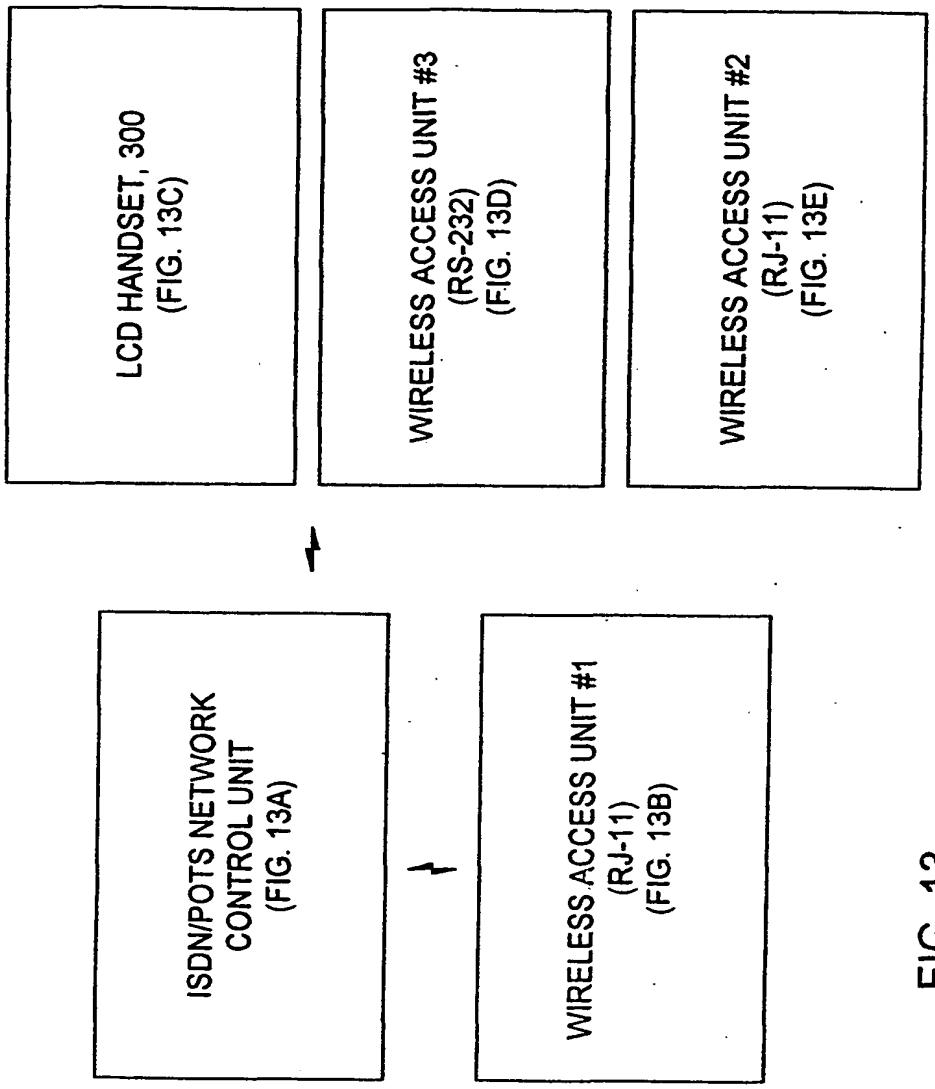


FIG. 13
ISDN HOME PERSONAL
COMMUNICATIONS SYSTEM

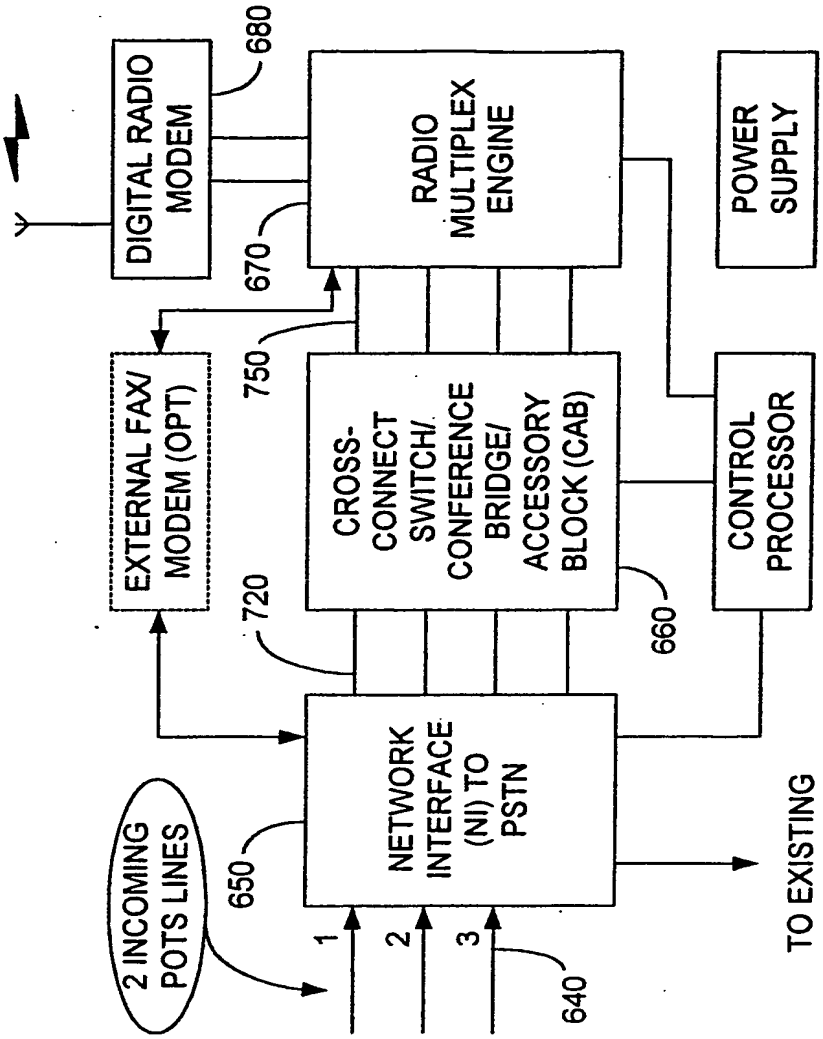


FIG. 13A

ISDNPOTS NETWORK CONTROL UNIT

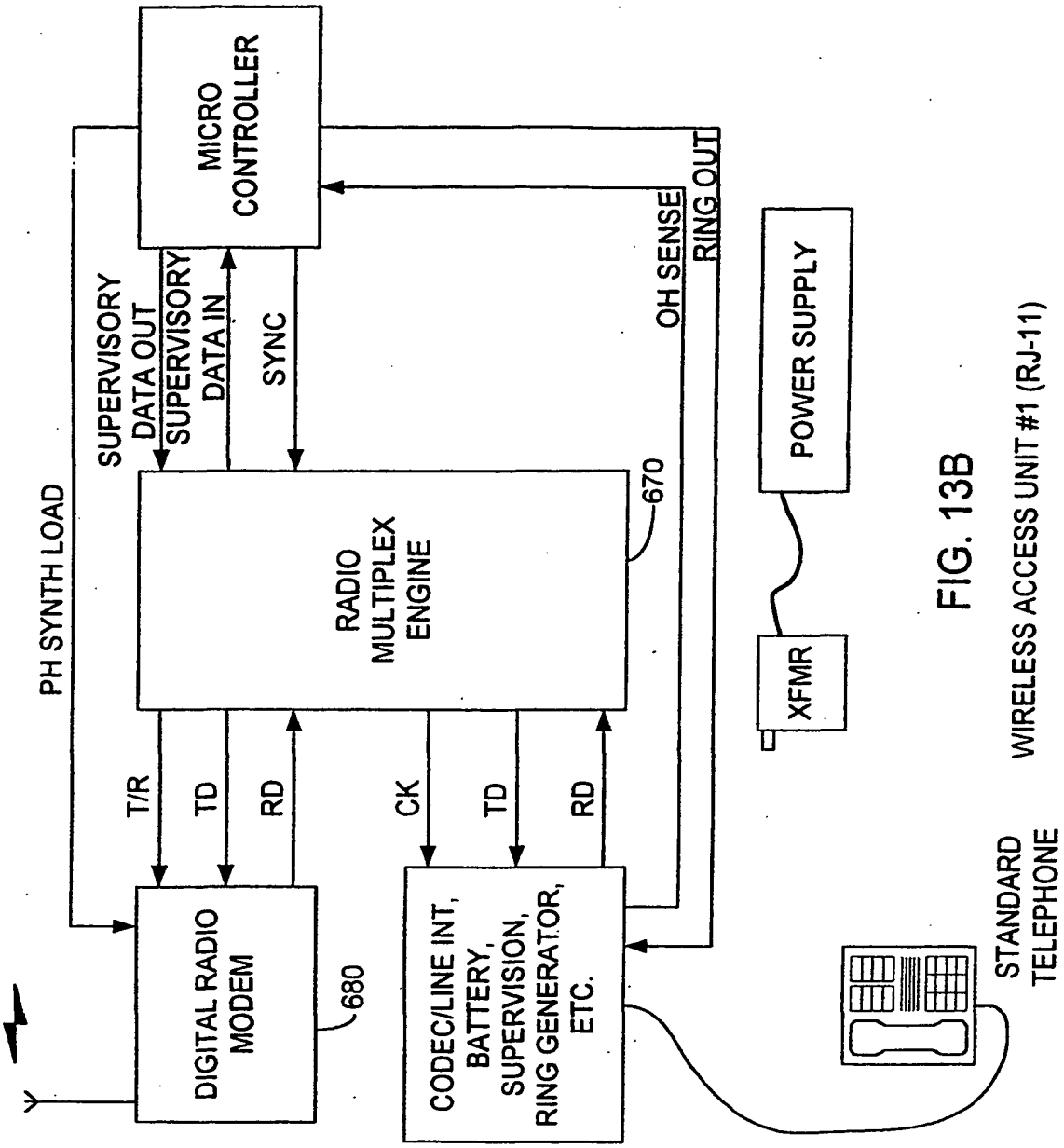

MICRO CONTROLLER
SUPERVISORY DATA OUT
SUPERVISORY DATA IN
SYNC
OH SENSE
RING OUT
PH SYNTH LOAD
RADIO MULTIPLEX ENGINE
670
POWER SUPPLY
XFMR
T/R
TD
RD
CK
TD
RD
DIGITAL RADIO MODEM
680
CODEC/LINE INT, BATTERY, SUPERVISION, RING GENERATOR, ETC.
STANDARD TELEPHONE
WIRELESS ACCESS UNIT #1 (RJ-11)

FIG. 13B

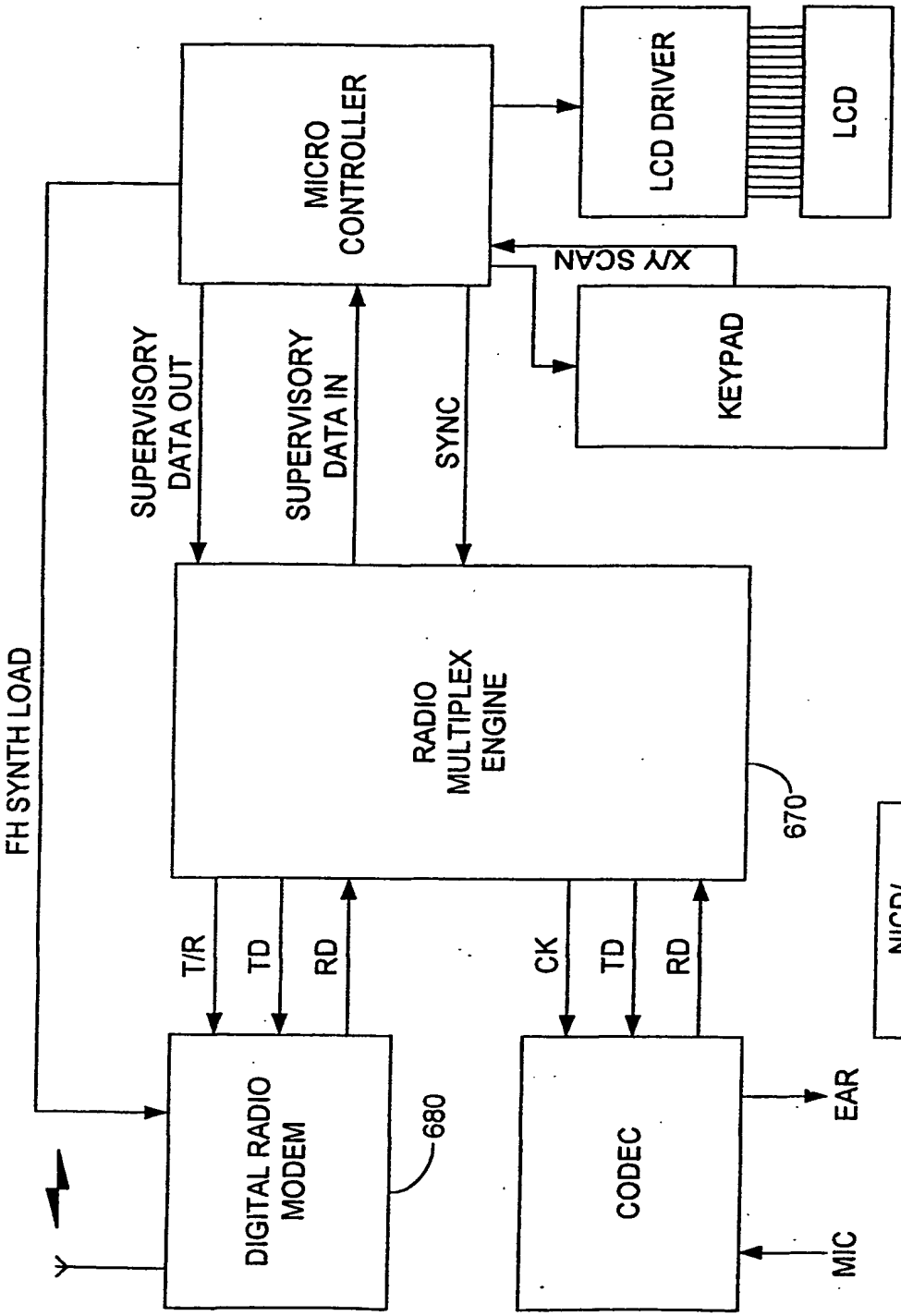


FIG. 13C

LCD HANDSET, 300

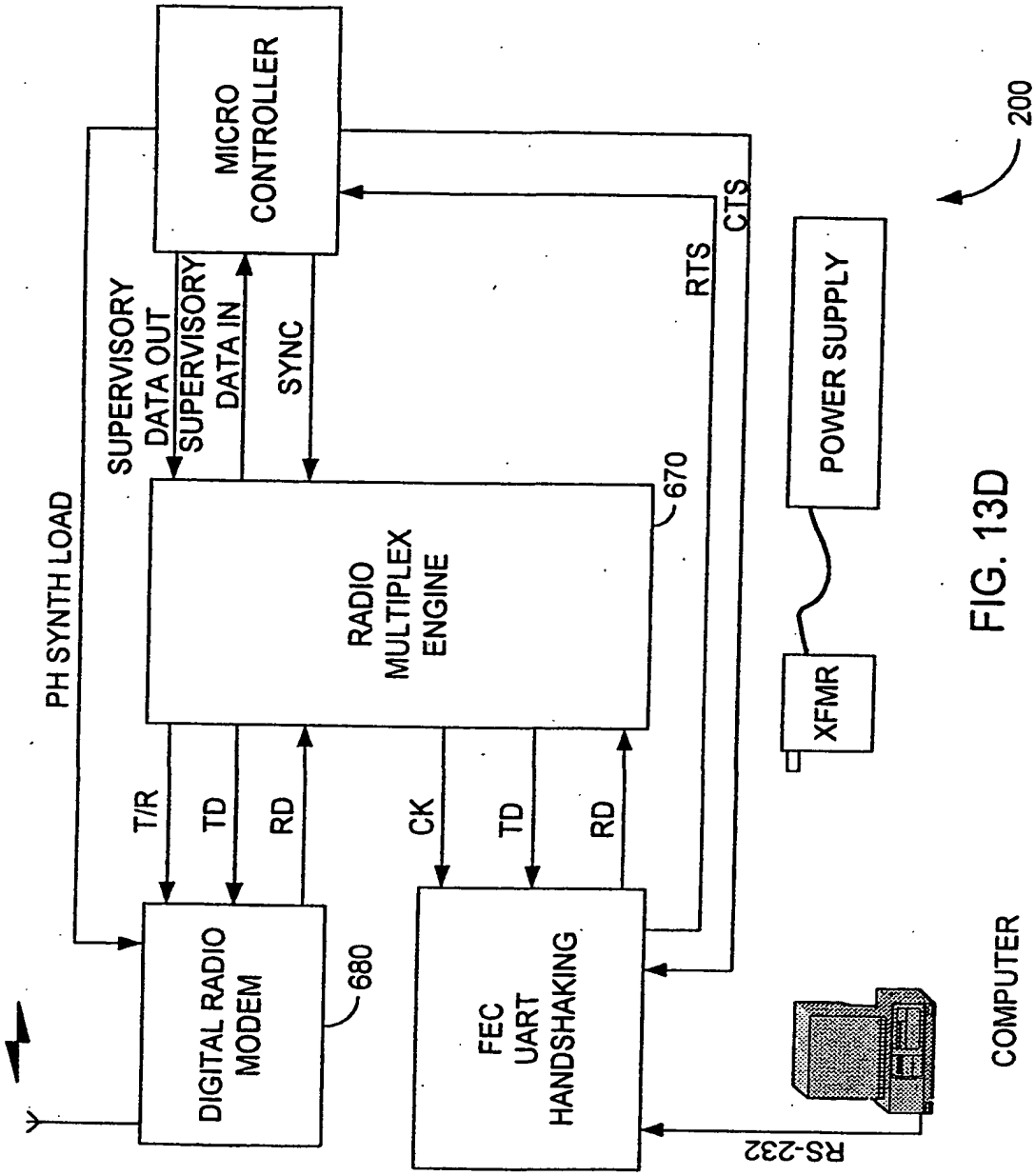


FIG. 13D

WIRELESS ACCESS UNIT #3 (RS-232)

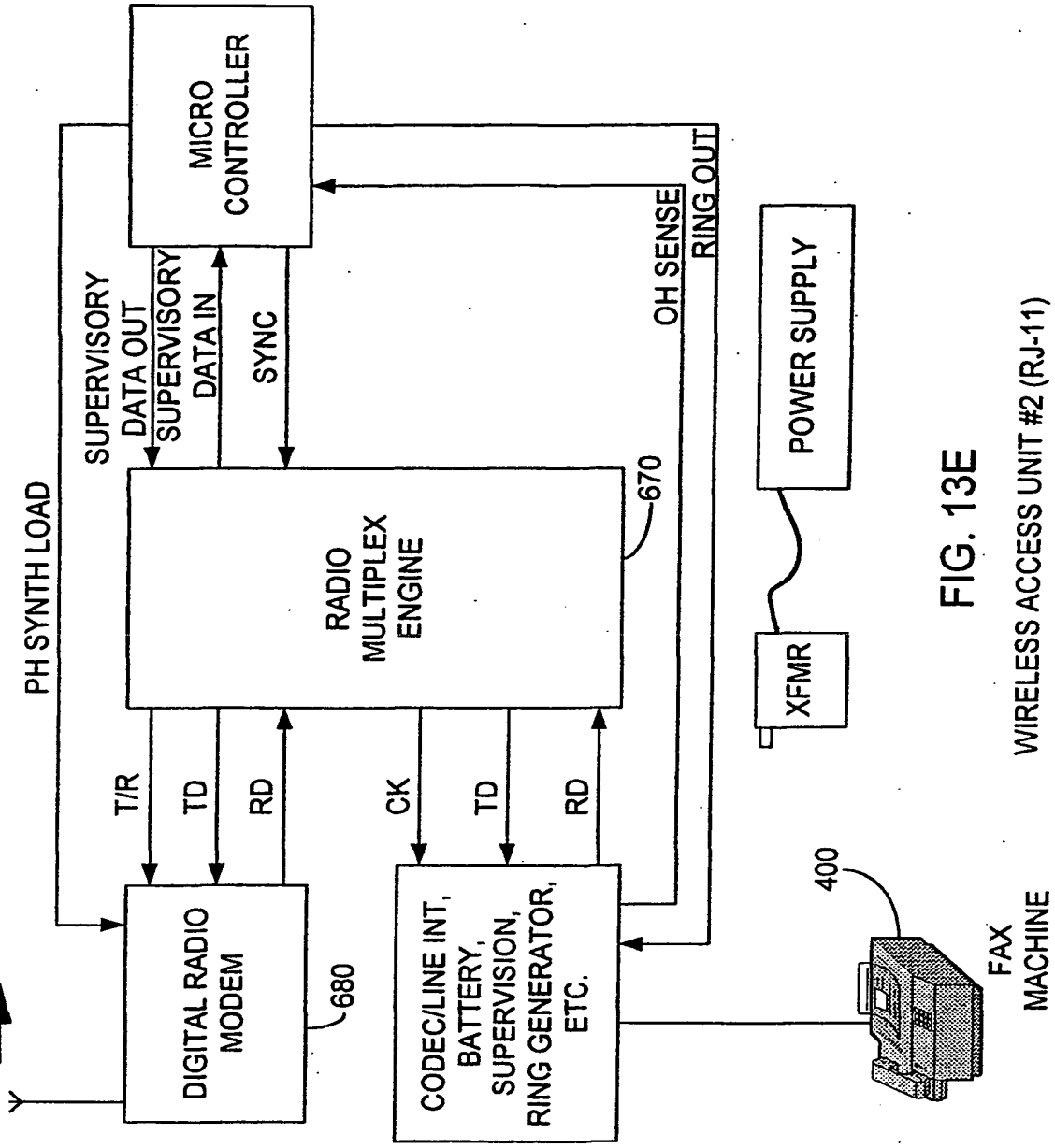


FIG. 13E

WIRELESS ACCESS UNIT #2 (RJ-11)

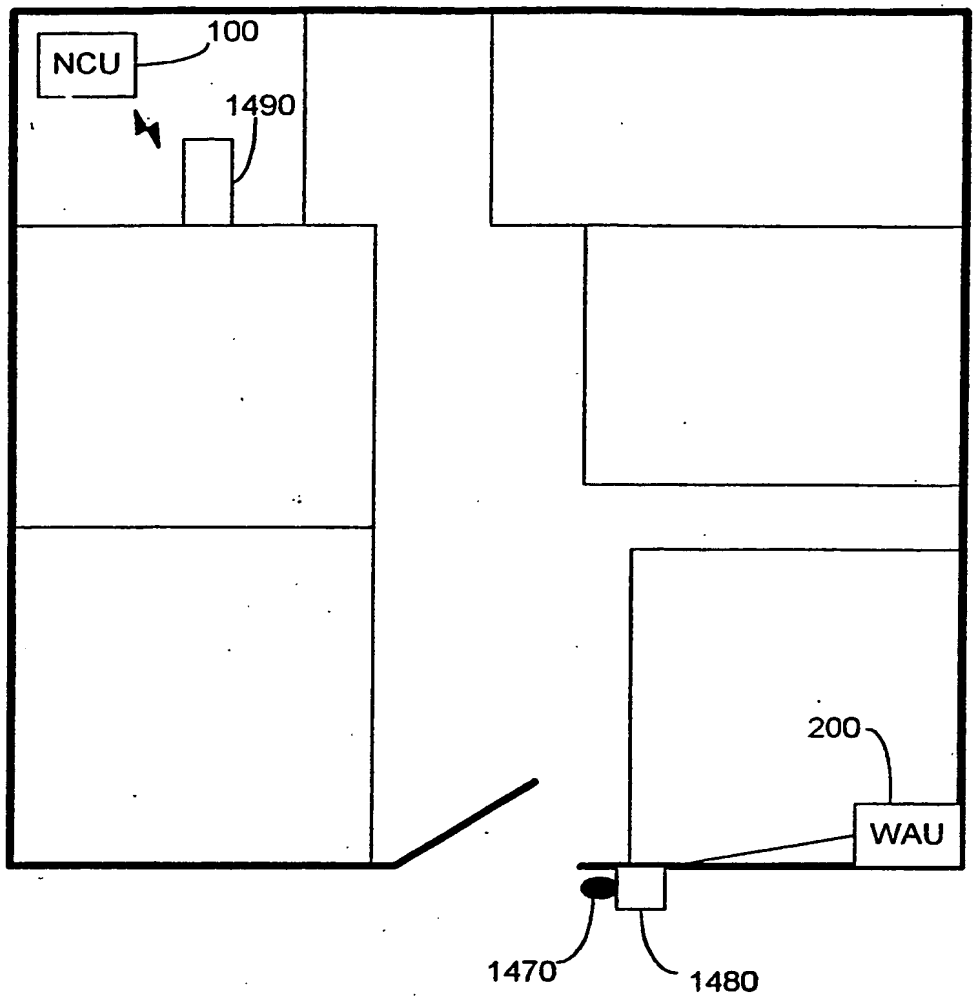


FIG. 14

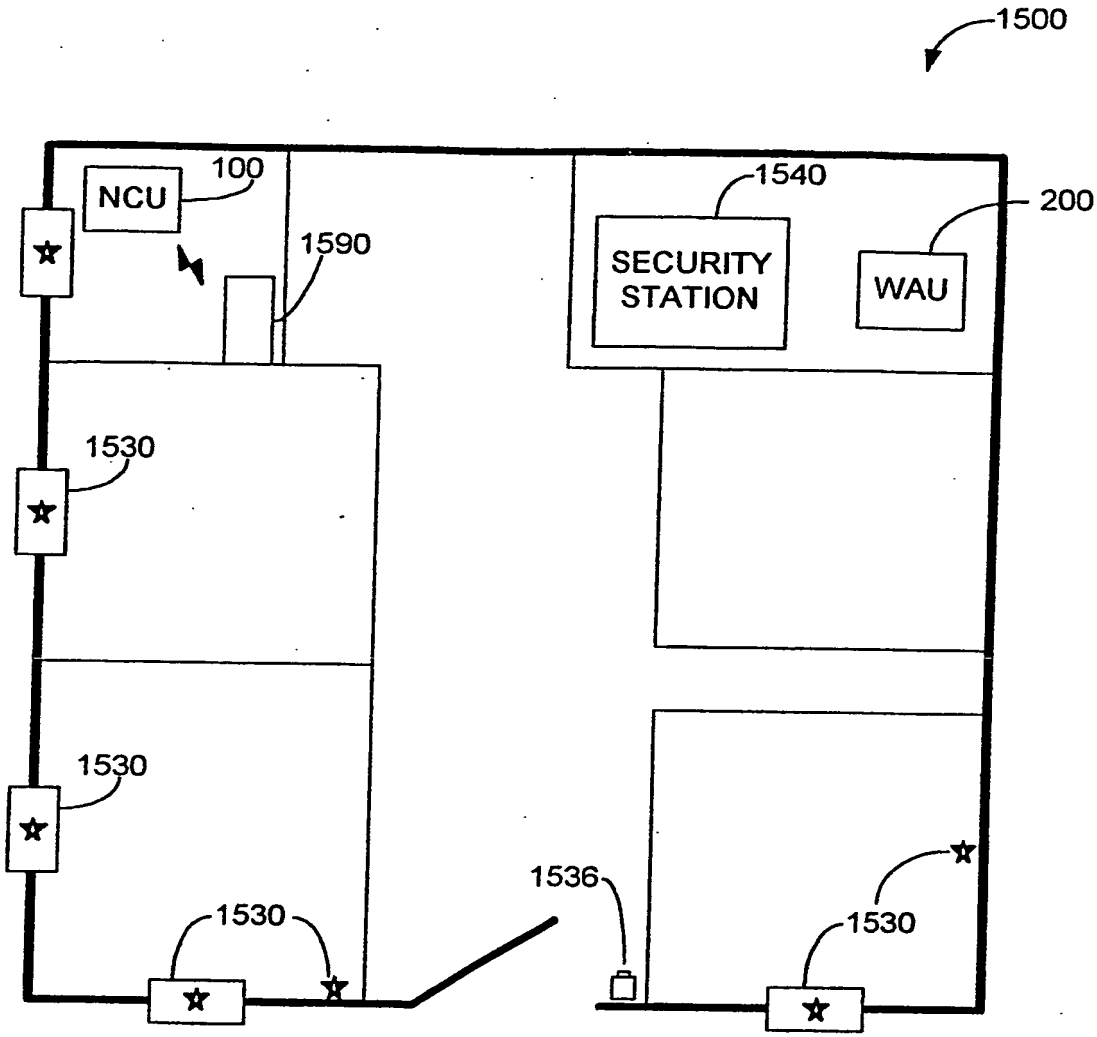

1500
NCU
100
1590
1540
SECURITY STATION
WAU
200
1530
1530
1530
1536
1530

FIG. 15

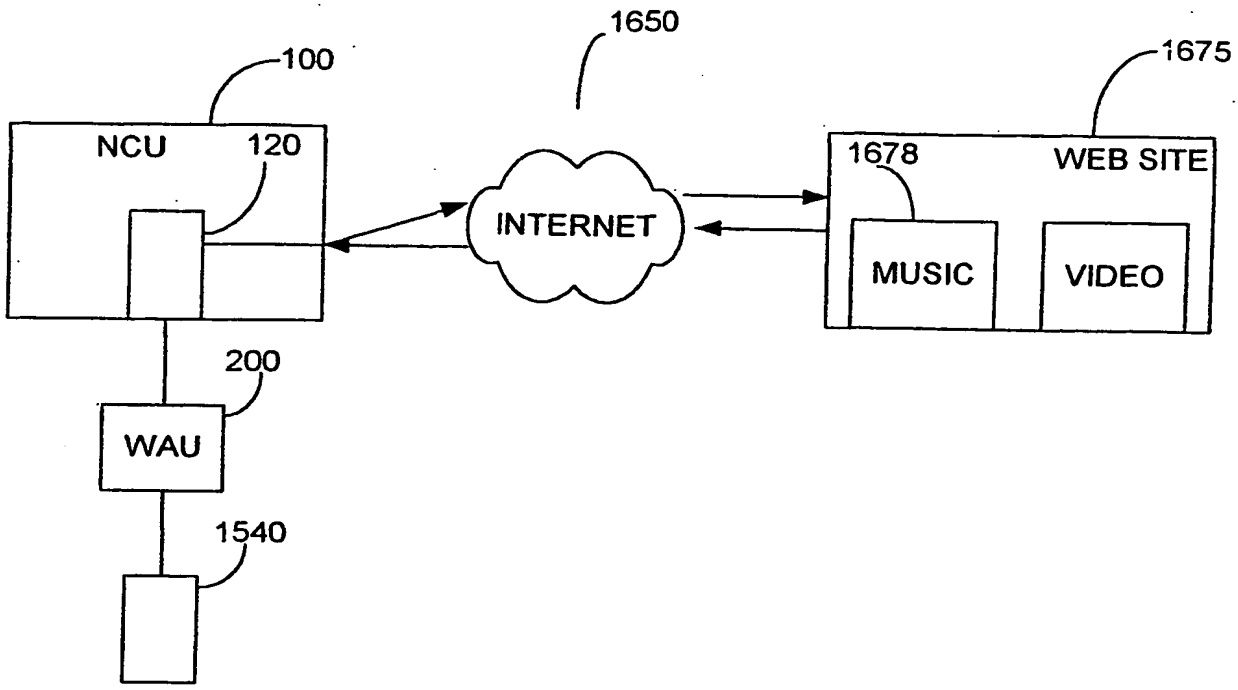

1650
100
1675
NCU
120
1678
WEB SITE
INTERNET
MUSIC
VIDEO
200
WAU
1540

FIG. 16

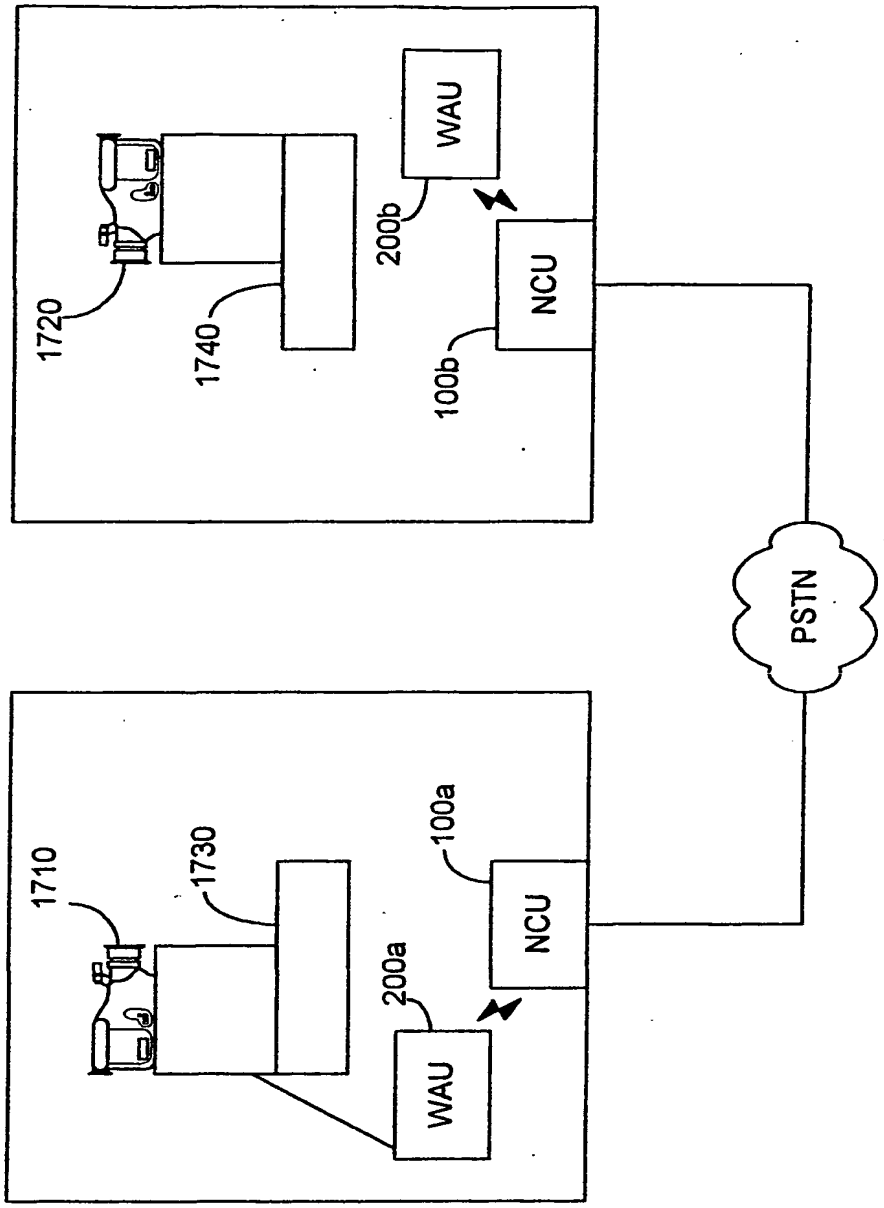


FIG. 17A

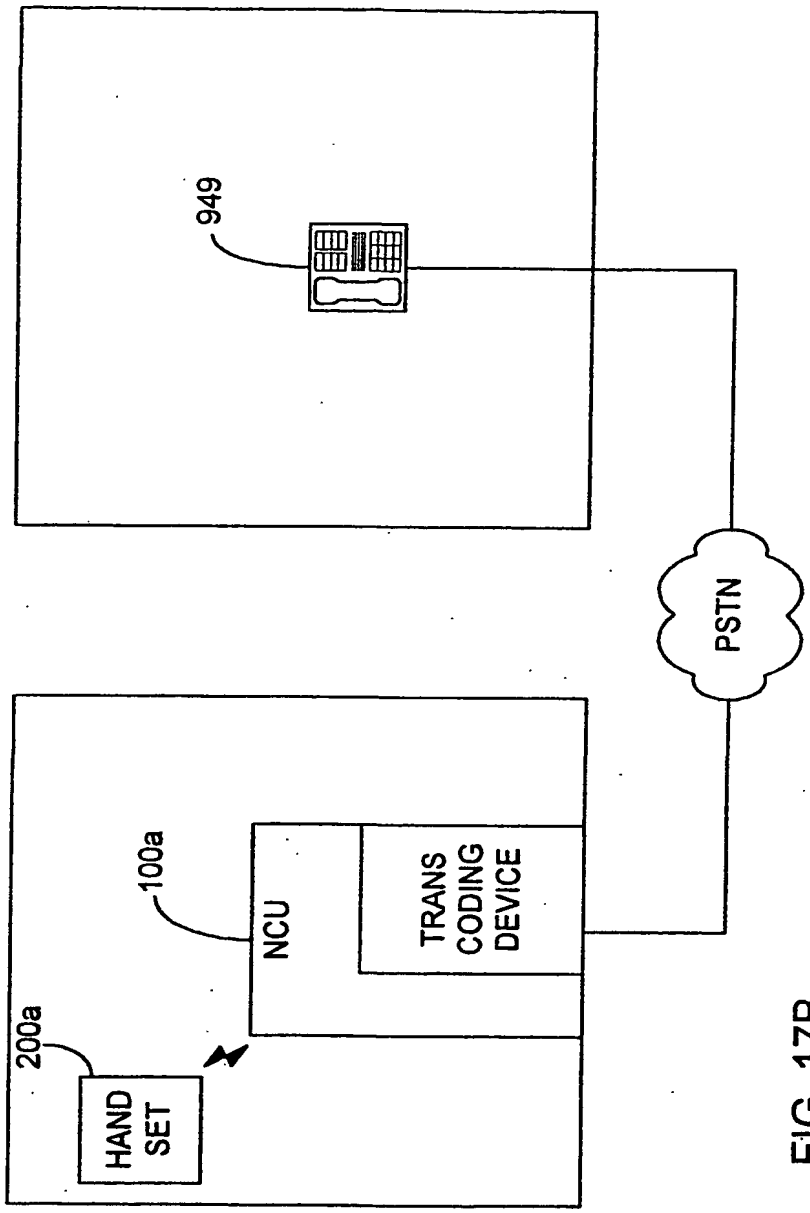


FIG. 17B

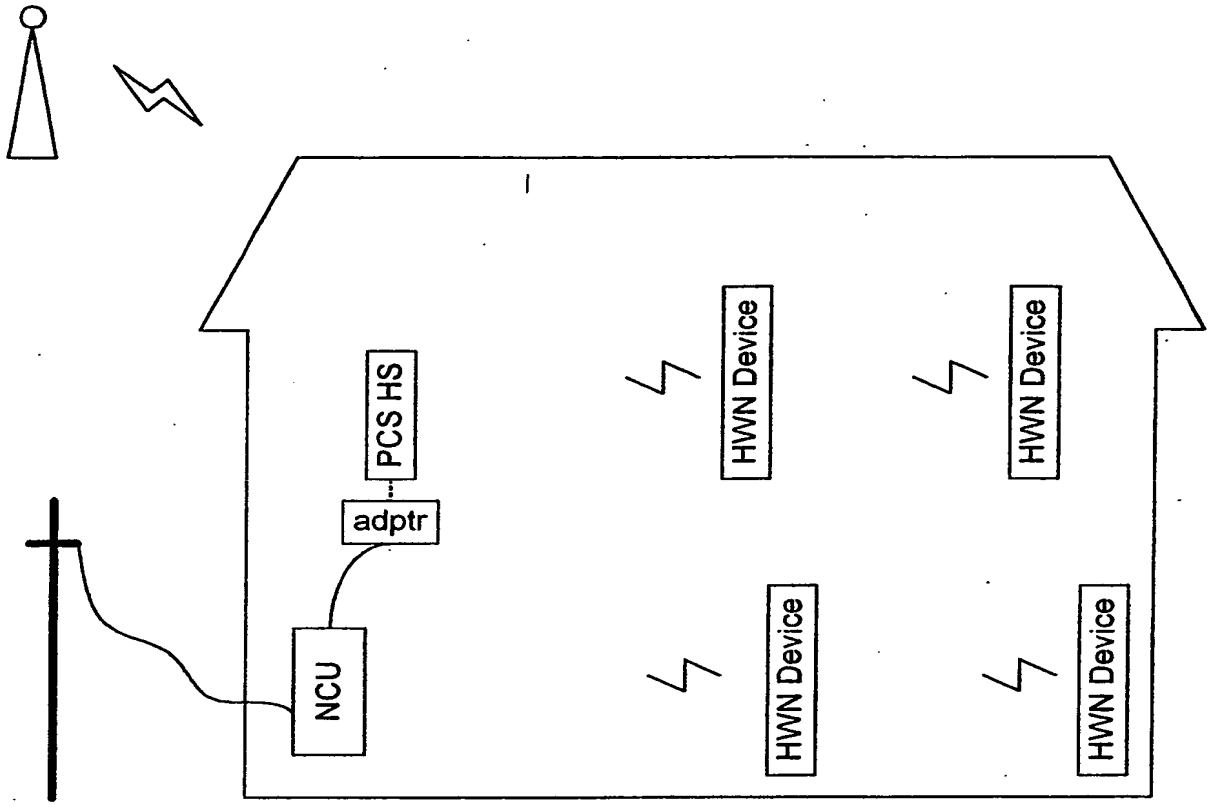


FIG. 18

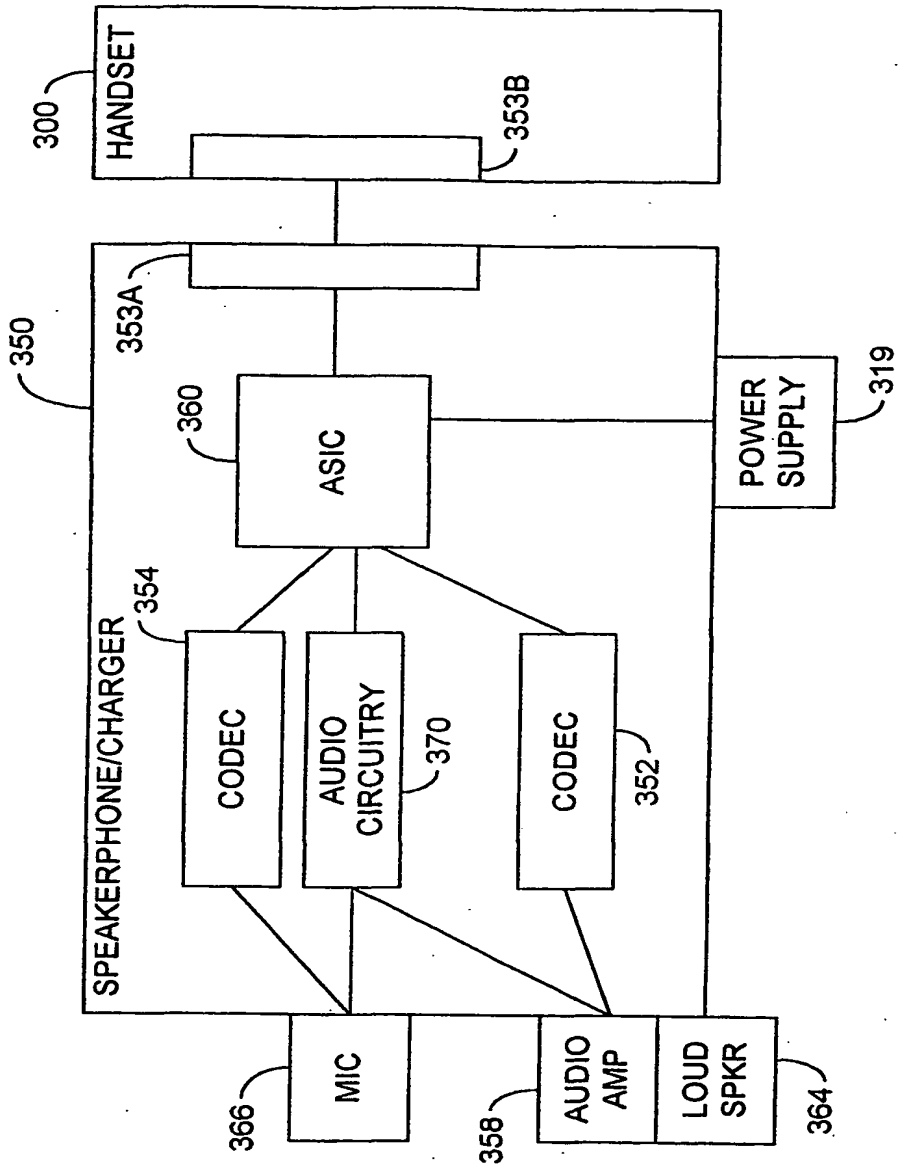

300
HANDSET
353B
350
353A
360
ASIC
POWER SUPPLY
319
354
SPEAKERPHONE/CHARGER
CODEC
AUDIO CIRCUITRY
370
CODEC
352
366
MIC
358
AUDIO AMP
LOUD SPKR
364

FIG. 19

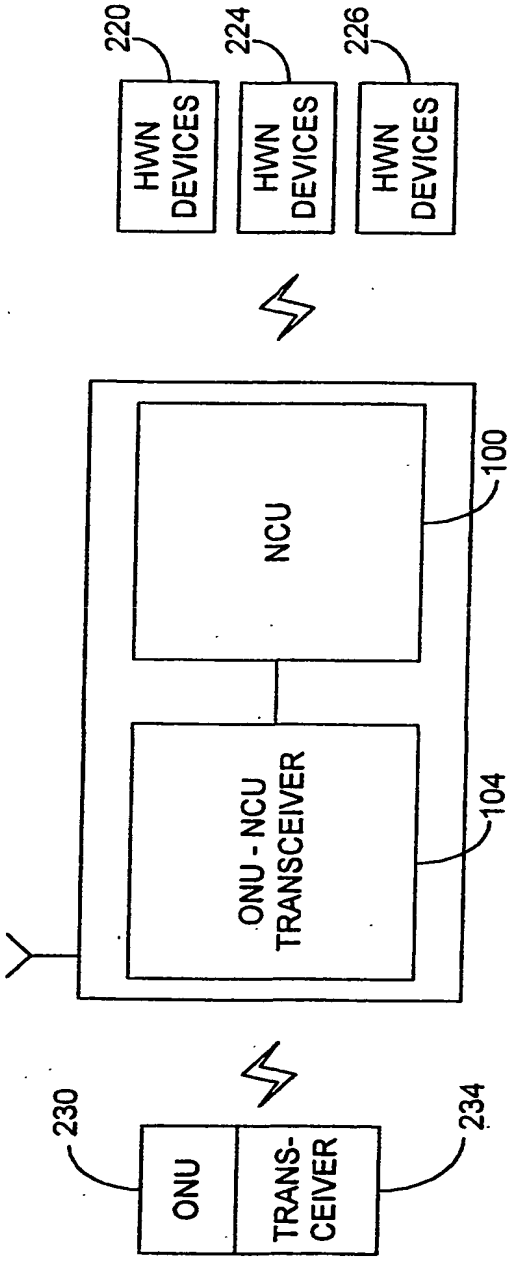

220
224
226
HWN DEVICES
HWN DEVICES
HWN DEVICES
NCU
100
ONU - NCU TRANSCEIVER
104
230
ONU
TRANS-CEIVER
234

FIG. 20

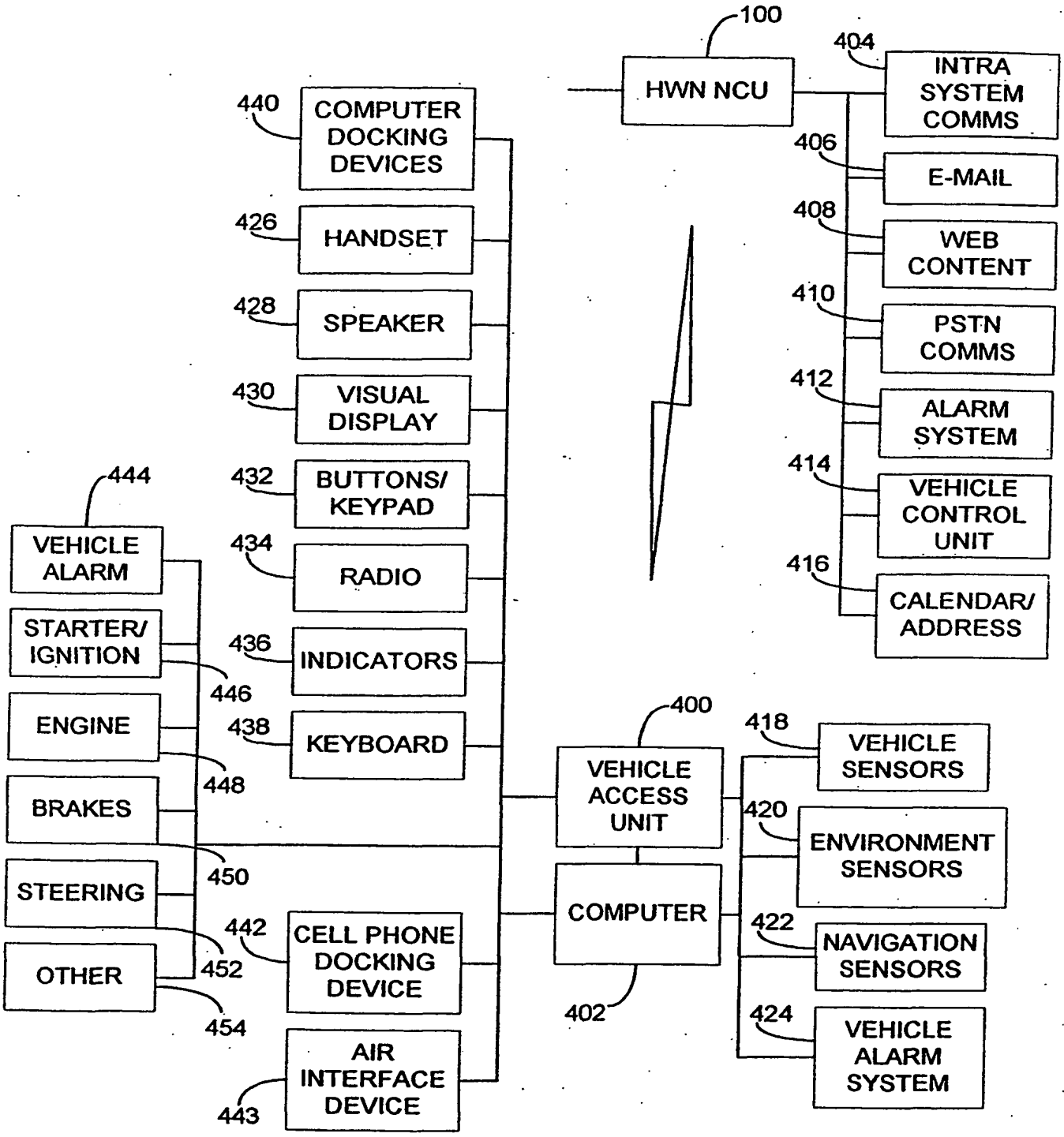

100
HWN NCU
404
INTRA SYSTEM COMMS
406
E-MAIL
408
WEB CONTENT
410
PSTN COMMS
412
ALARM SYSTEM
414
VEHICLE CONTROL UNIT
416
CALENDAR/ ADDRESS
440
COMPUTER DOCKING DEVICES
426
HANDSET
428
SPEAKER
430
VISUAL DISPLAY
432
BUTTONS/ KEYPAD
434
RADIO
436
INDICATORS
438
KEYBOARD
444
VEHICLE ALARM
STARTER/ IGNITION
446
ENGINE
448
BRAKES
450
STEERING
452
OTHER
454
442
CELL PHONE DOCKING DEVICE
AIR INTERFACE DEVICE
443
400
VEHICLE ACCESS UNIT
COMPUTER
402
418
VEHICLE SENSORS
420
ENVIRONMENT SENSORS
422
NAVIGATION SENSORS
424
VEHICLE ALARM SYSTEM

FIG. 21

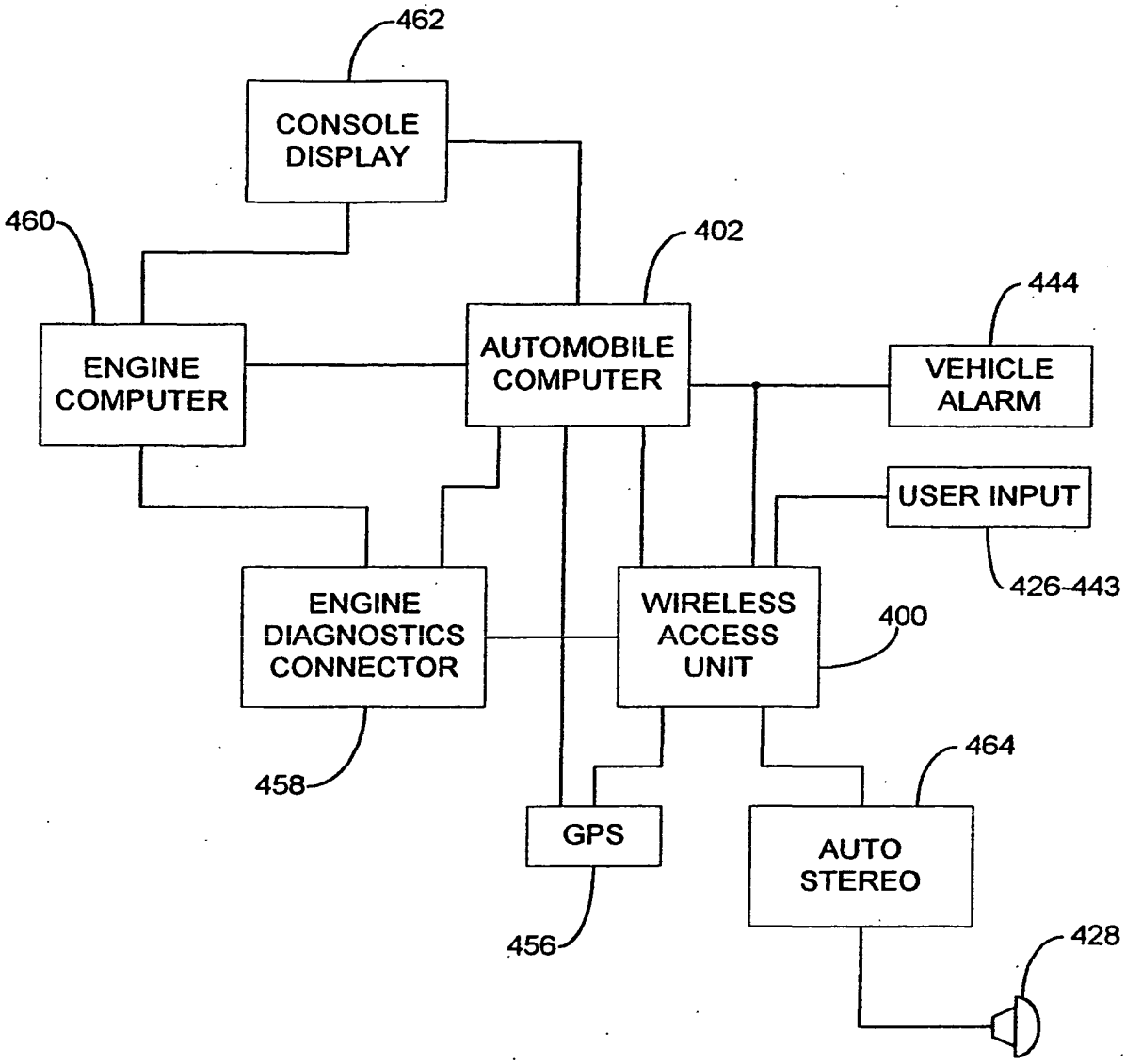

462
CONSOLE DISPLAY
460
402
444
ENGINE COMPUTER
AUTOMOBILE COMPUTER
VEHICLE ALARM
USER INPUT
426-443
ENGINE DIAGNOSTICS CONNECTOR
WIRELESS ACCESS UNIT
400
458
464
GPS
AUTO STEREO
456
428

FIG. 22

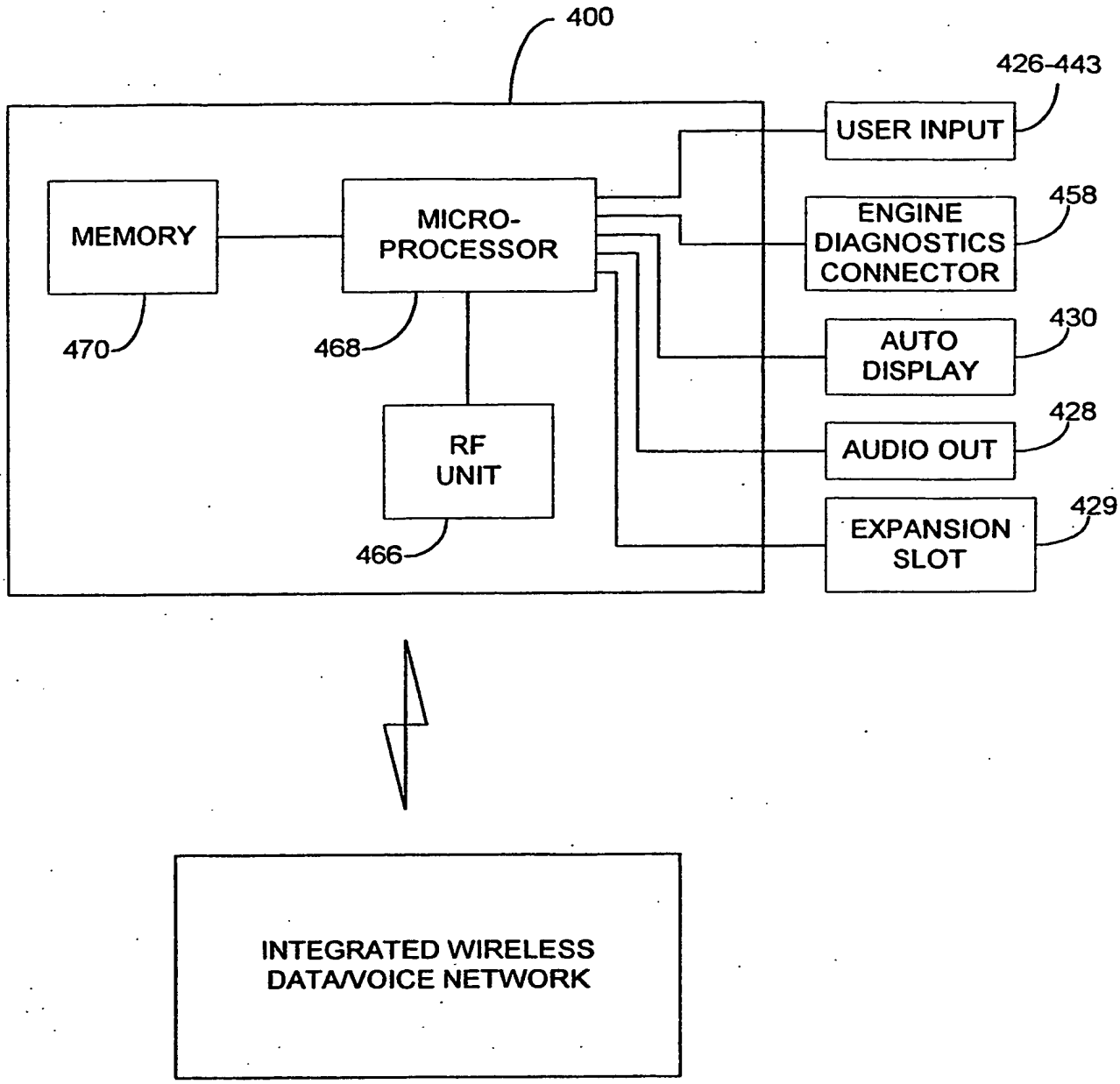

400
426-443
USER INPUT
MEMORY
MICRO-
PROCESSOR
ENGINE
DIAGNOSTICS
CONNECTOR
458
AUTO
DISPLAY
430
AUDIO OUT
428
EXPANSION
SLOT
429
RF
UNIT
470
468
466
INTEGRATED WIRELESS
DATA/VOICE NETWORK

FIG. 23

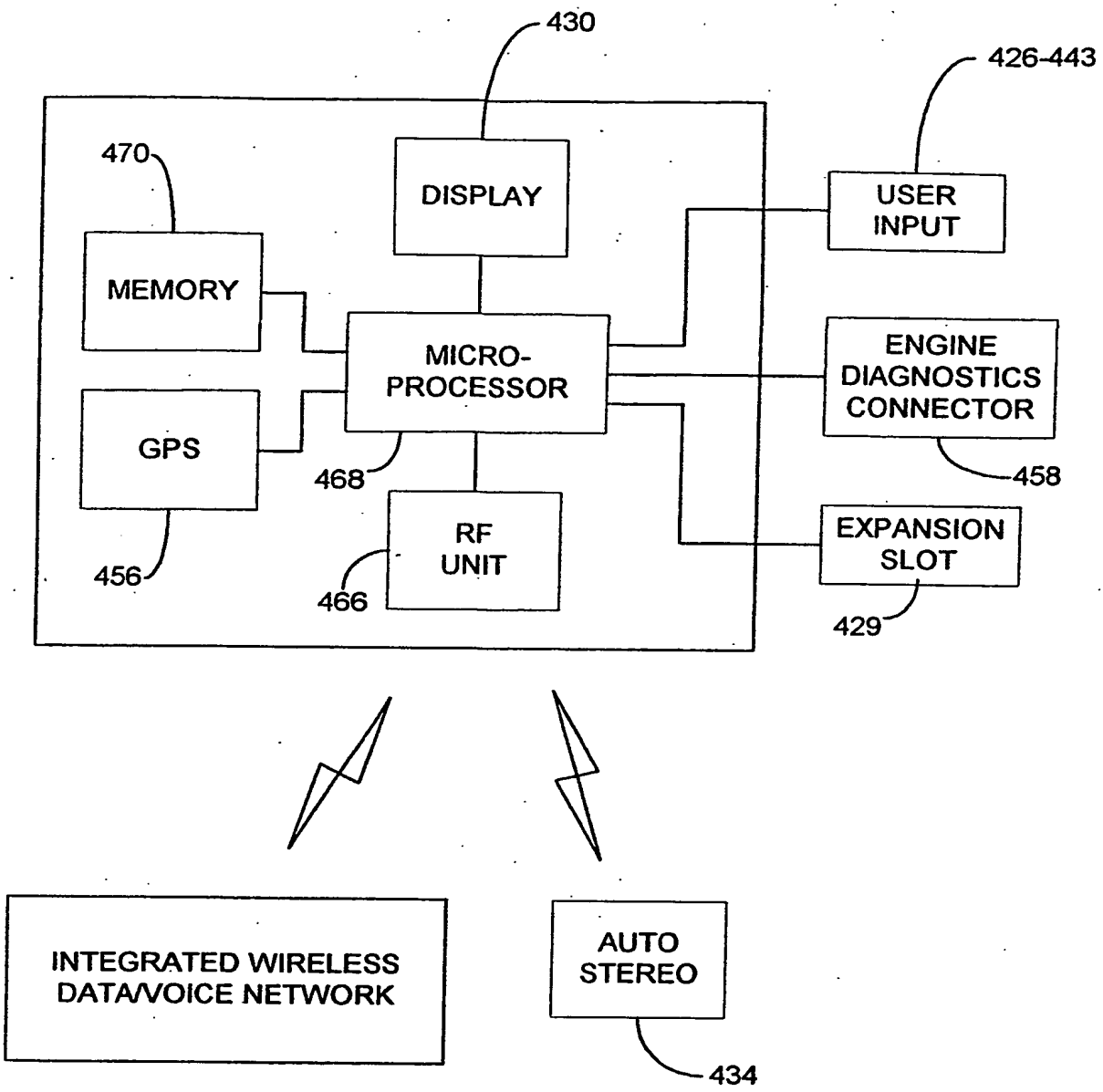

430
426-443
470
DISPLAY
USER INPUT
MEMORY
MICRO-PROCESSOR
ENGINE DIAGNOSTICS CONNECTOR
GPS
468
458
RF UNIT
EXPANSION SLOT
456
466
429
INTEGRATED WIRELESS DATA/VOICE NETWORK
AUTO STEREO
434

FIG. 24

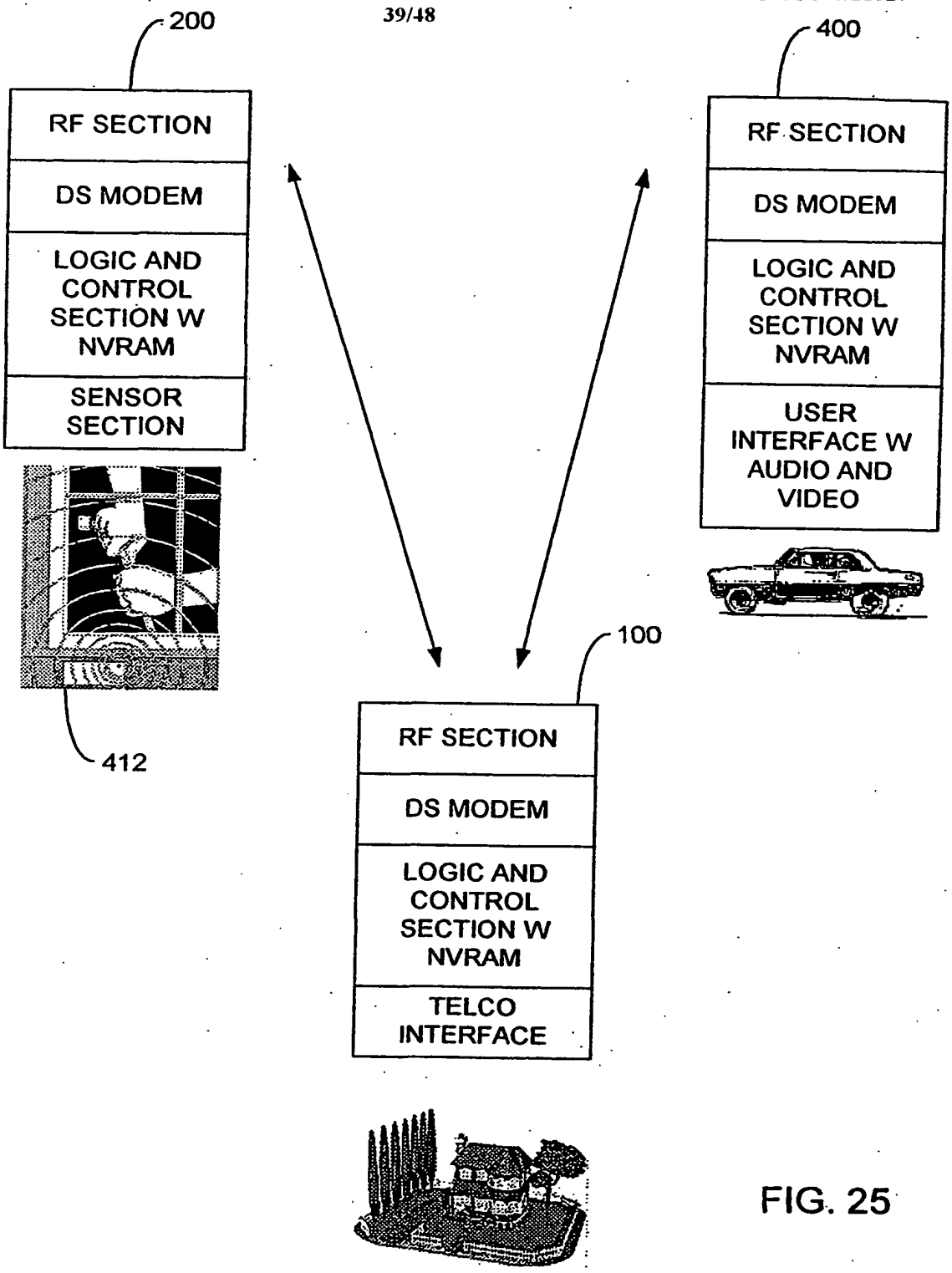


FIG. 25

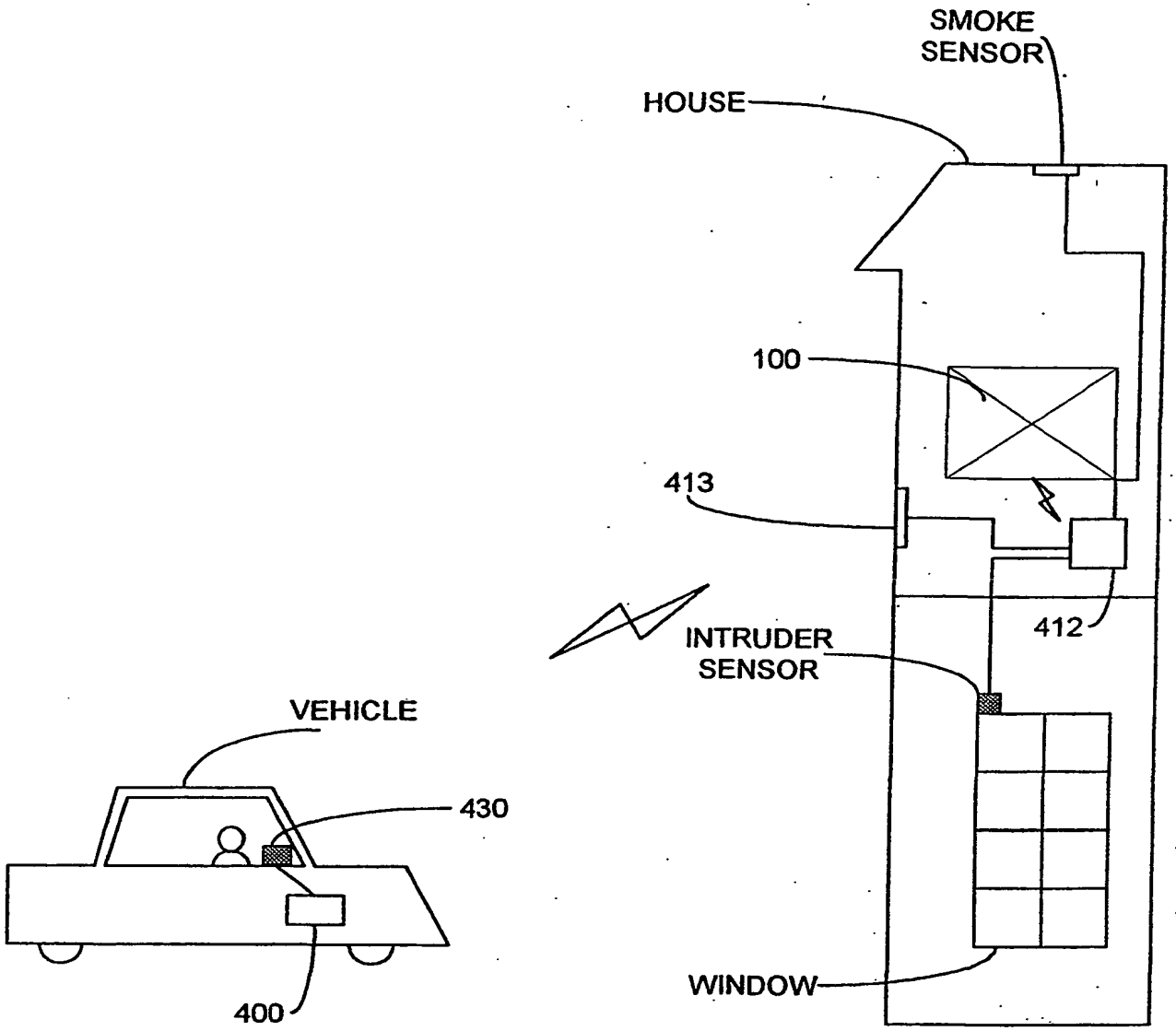


FIG. 26

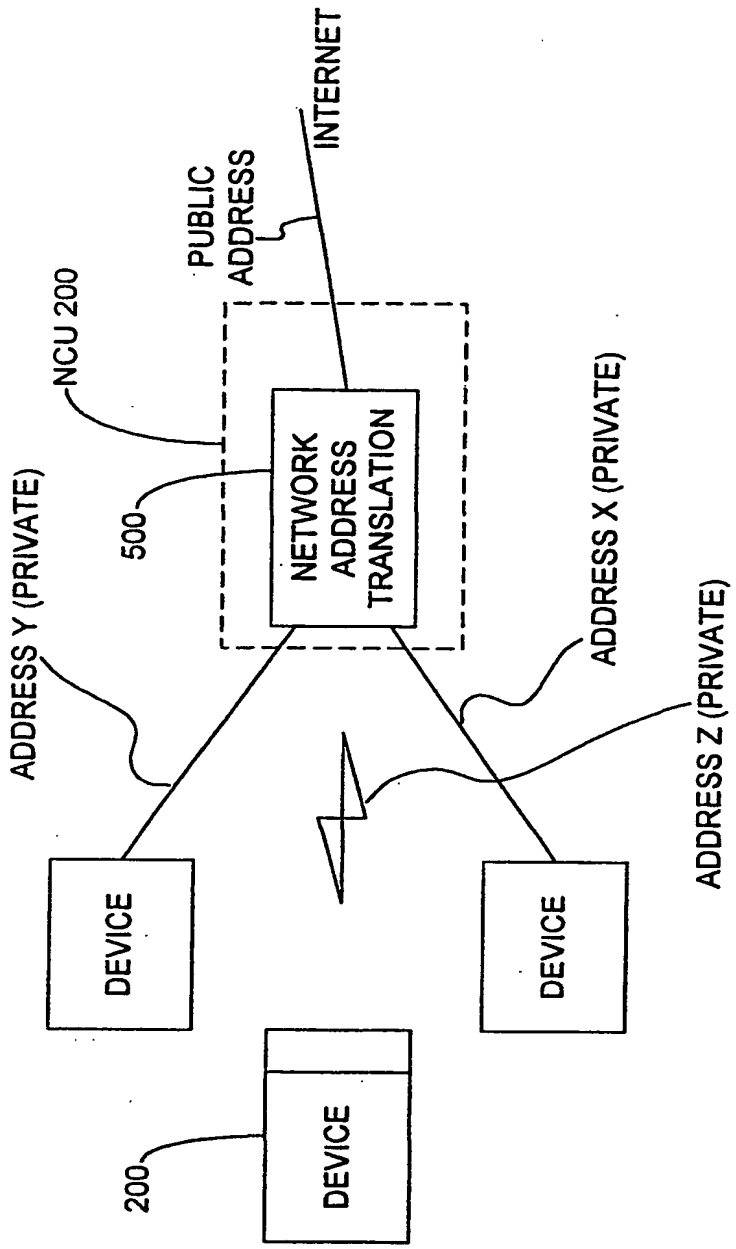

INTERNET
PUBLIC ADDRESS
NCU 200
500
NETWORK ADDRESS TRANSLATION
ADDRESS Y (PRIVATE)
ADDRESS X (PRIVATE)
ADDRESS Z (PRIVATE)
DEVICE
DEVICE
DEVICE
200

FIG. 27

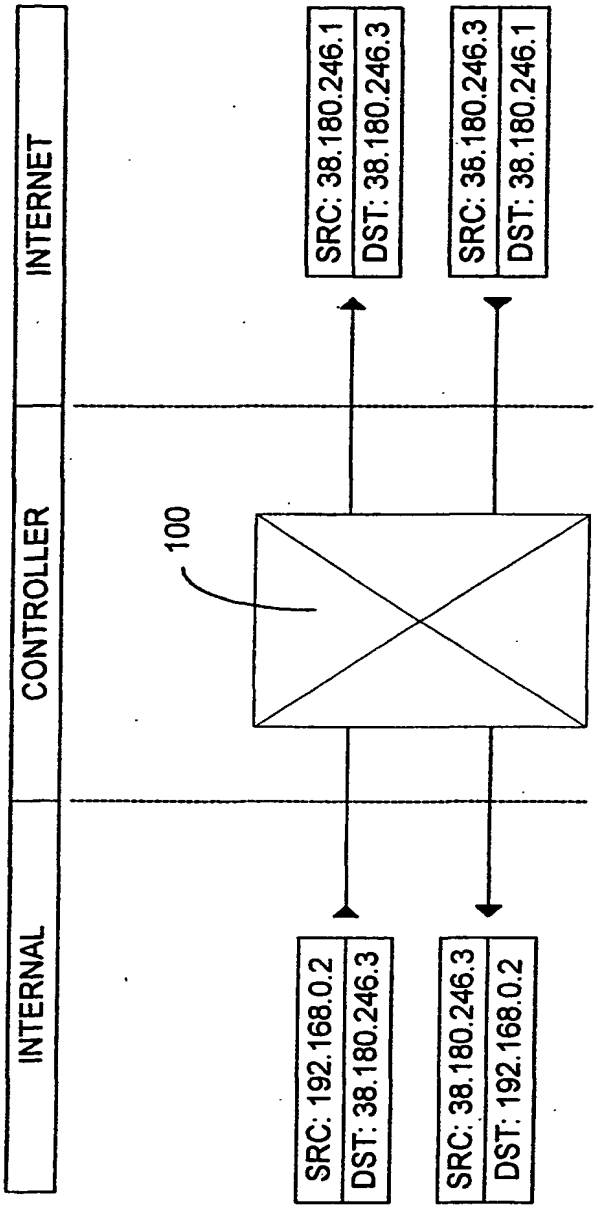

INTERNET
CONTROLLER
INTERNAL
100
SRC: 38.180.246.1
DST: 38.180.246.3
SRC: 38.180.246.3
DST: 38.180.246.1
SRC: 192.168.0.2
DST: 38.180.246.3
SRC: 38.180.246.3
DST: 192.168.0.2

FIG. 28

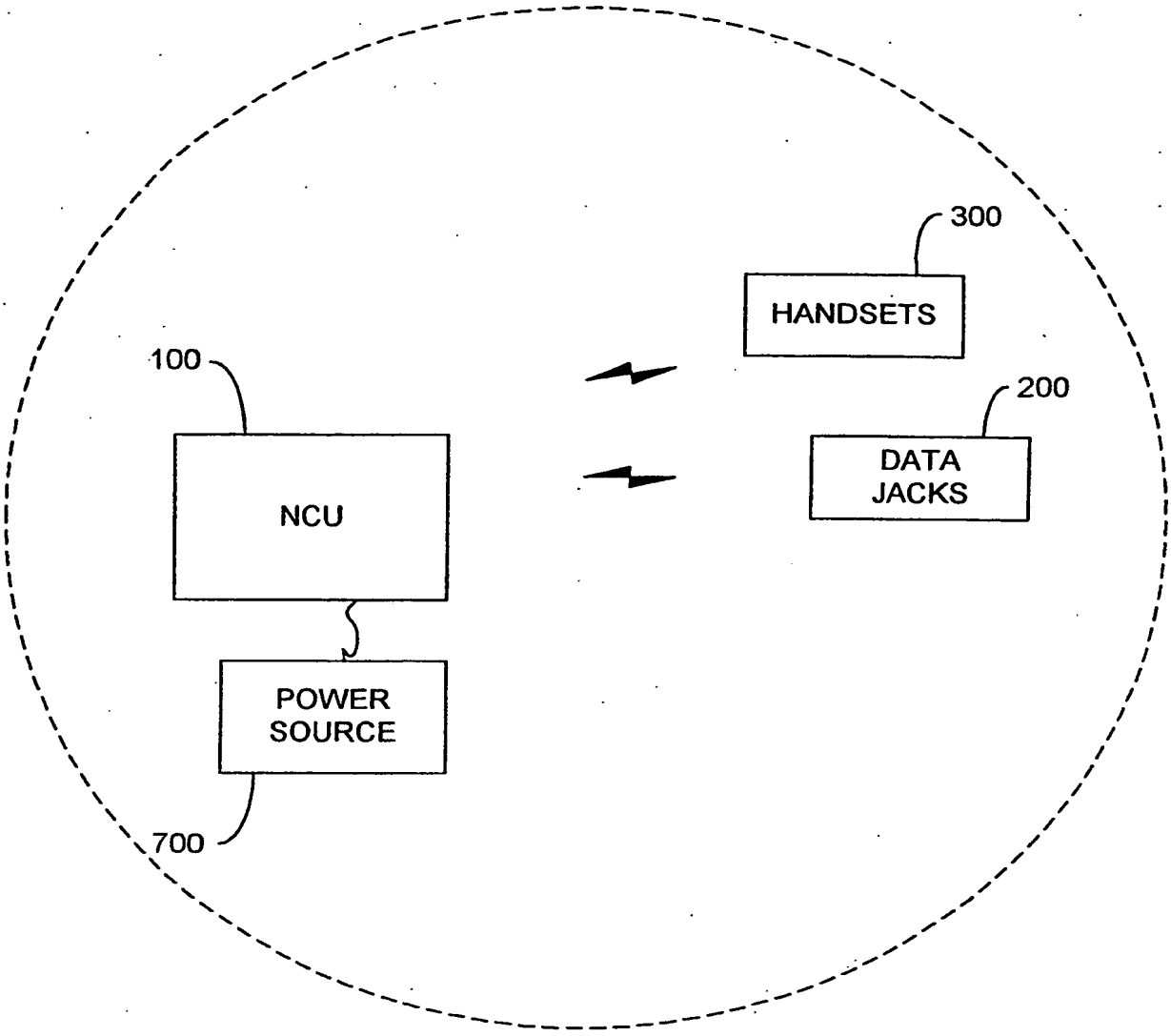


FIG. 29

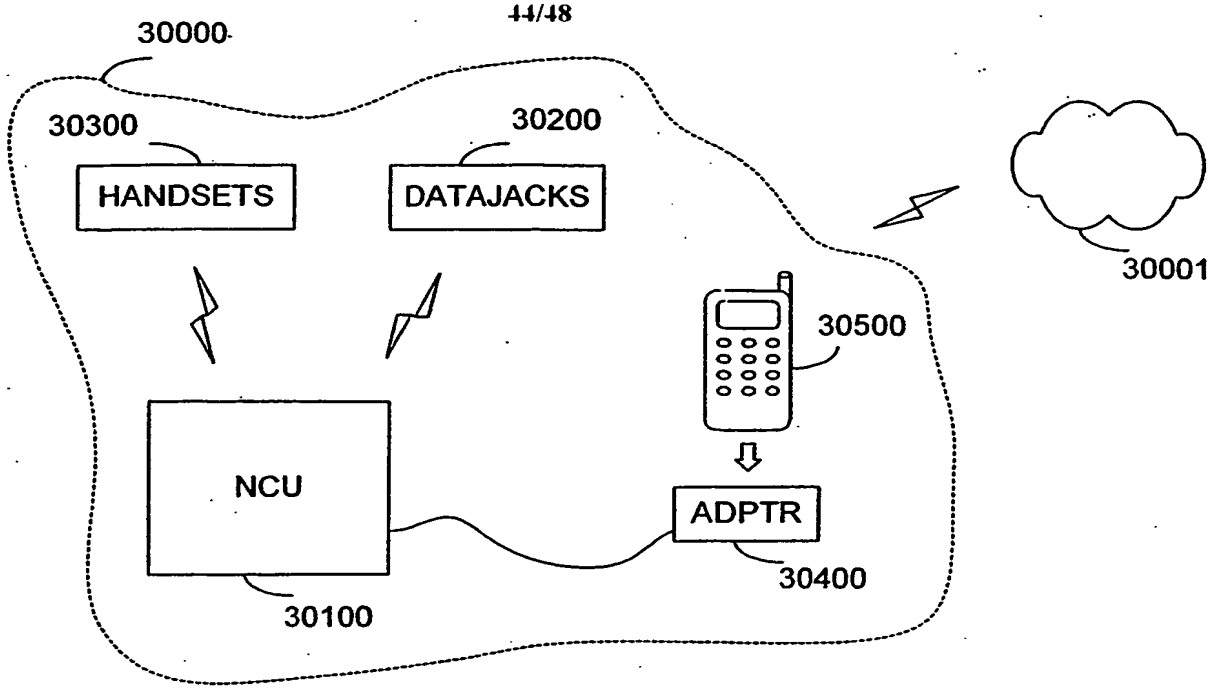

30000
30300
HANDSETS
30200
DATAJACKS
30001
30500
NCU
ADPTR
30400
30100

FIG. 30

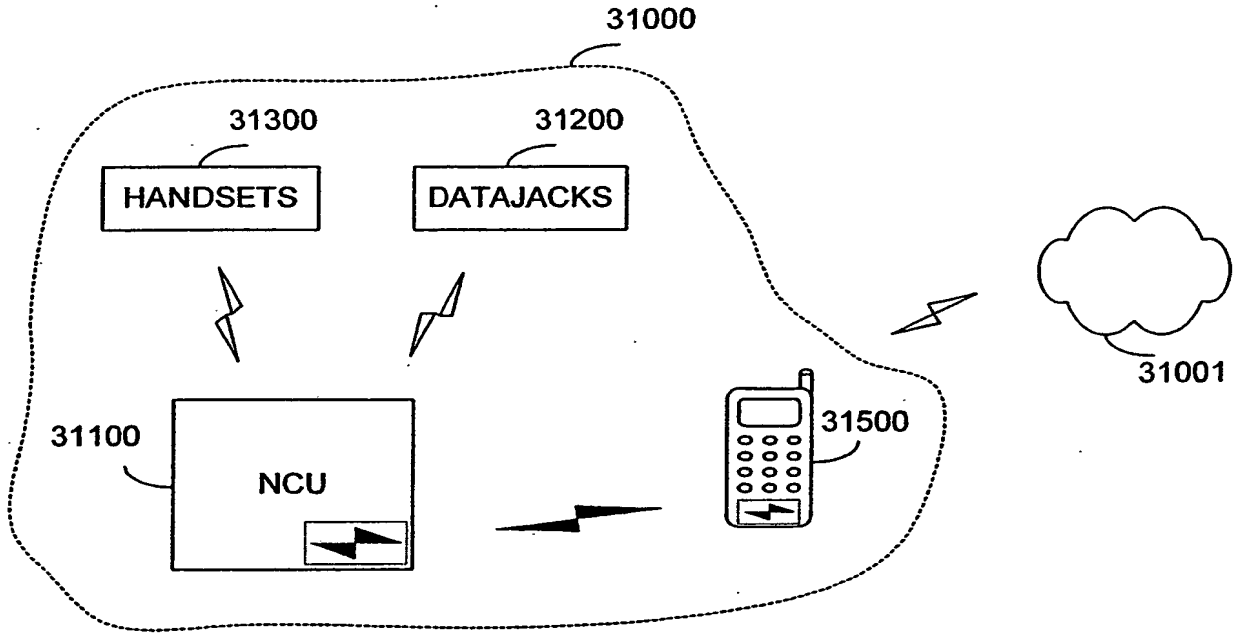

31000
31300
HANDSETS
31200
DATAJACKS
31001
31500
31100
NCU

FIG. 31

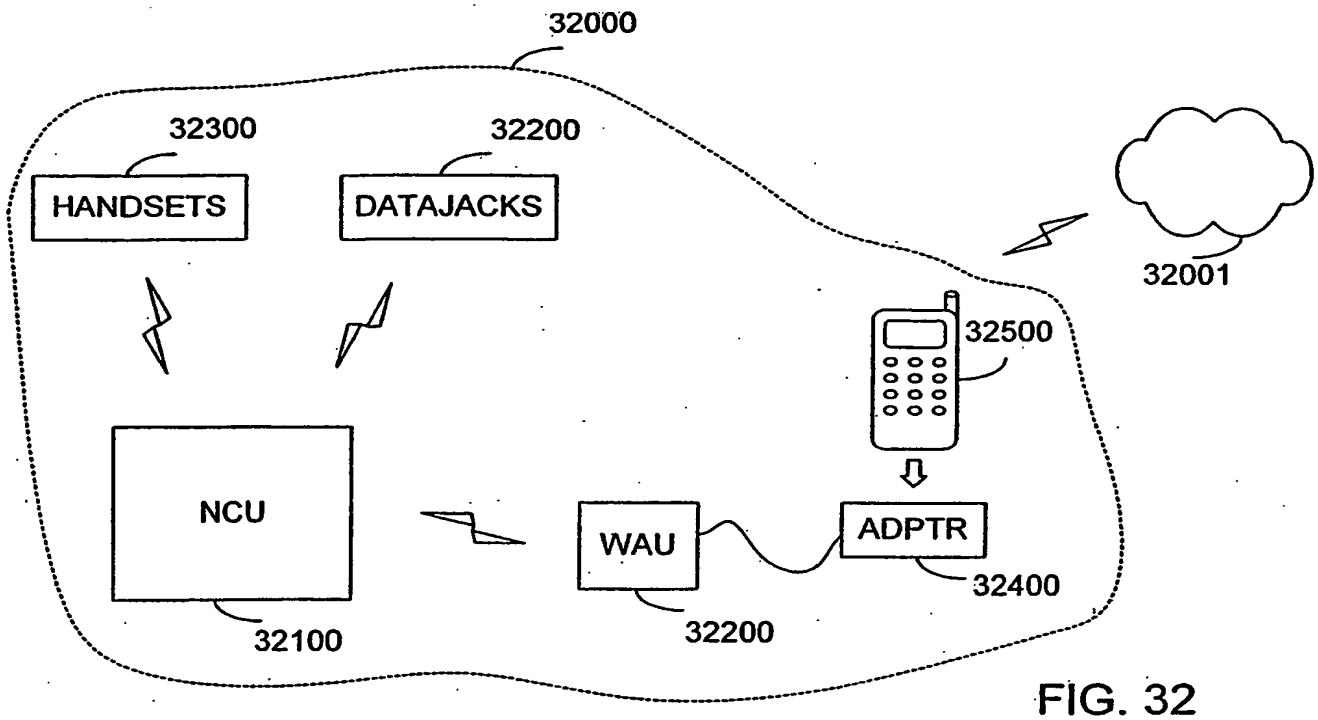

32000
32300
32200
HANDSETS
DATAJACKS
32001
32500
NCU
WAU
ADPTR
32400
32100
32200

FIG. 32

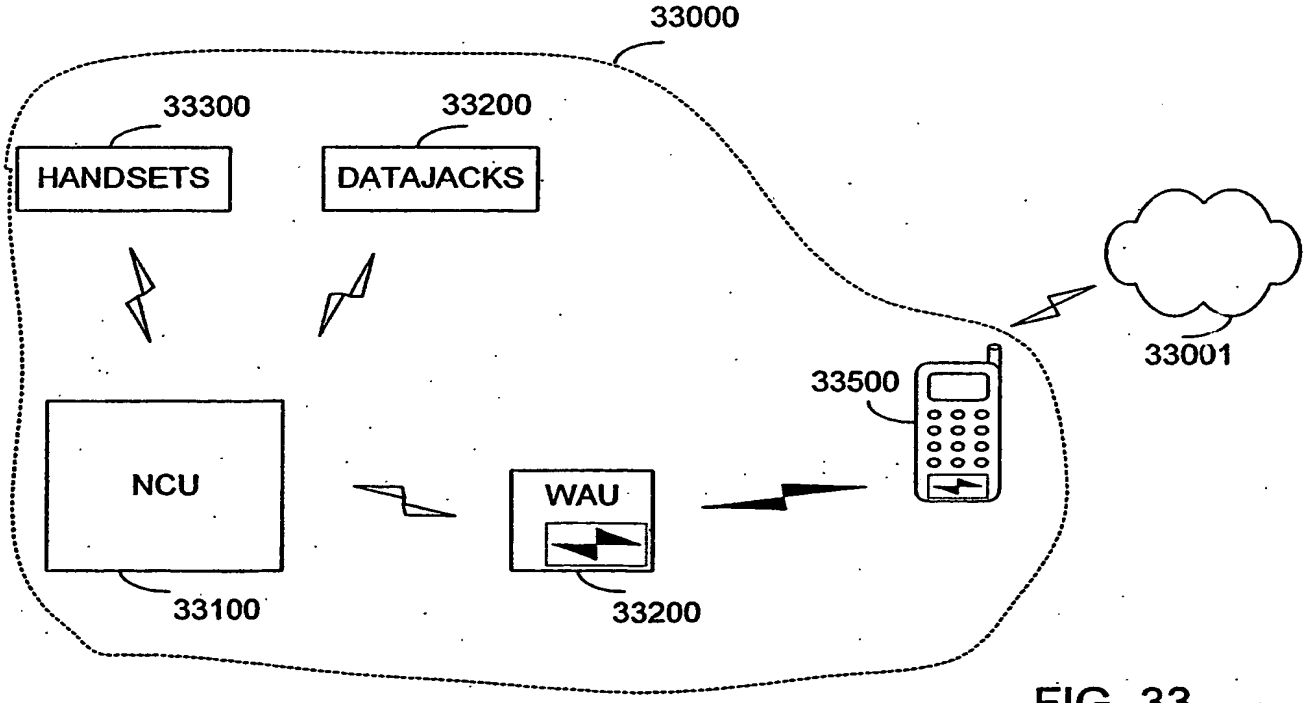

33000
33300
33200
HANDSETS
DATAJACKS
33001
33500
NCU
WAU
33100
33200

FIG. 33

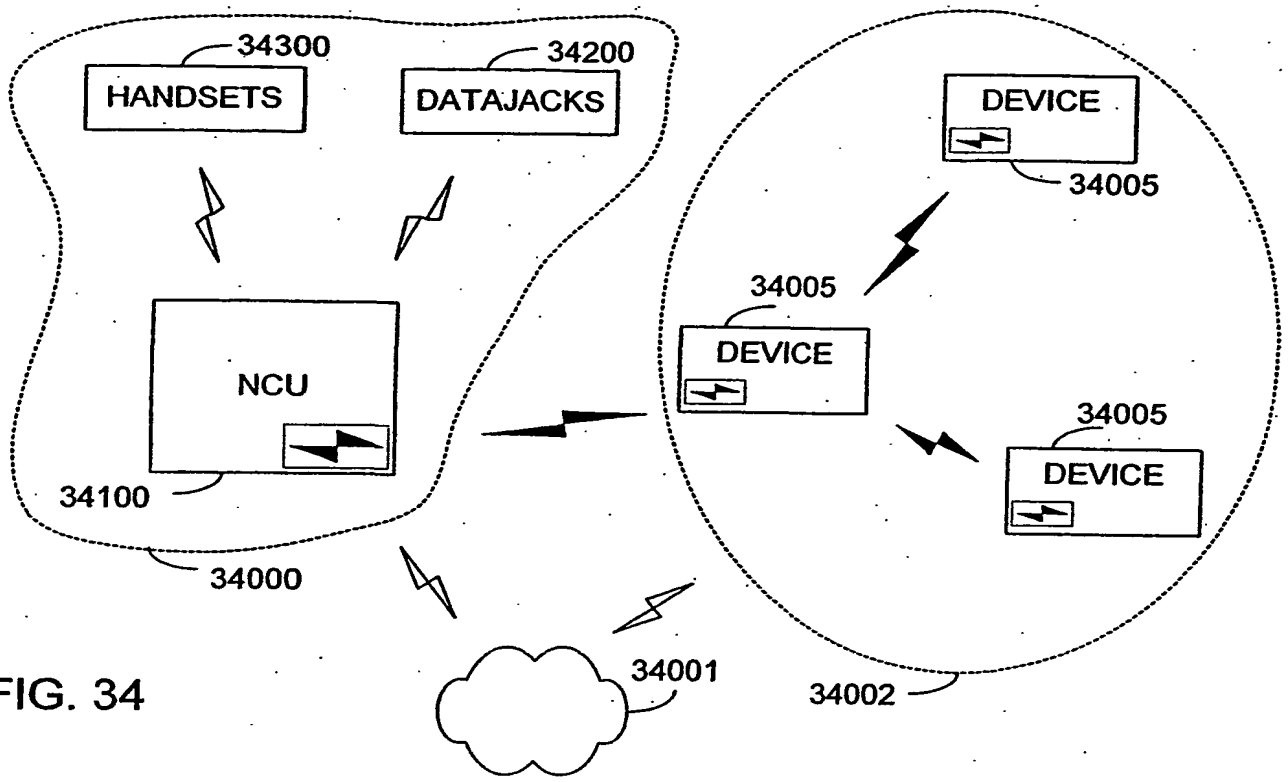

34300
HANDSETS
34200
DATAJACKS
NCU
34100
34000
DEVICE
34005
34005
DEVICE
34005
DEVICE
34001
34002

FIG. 34

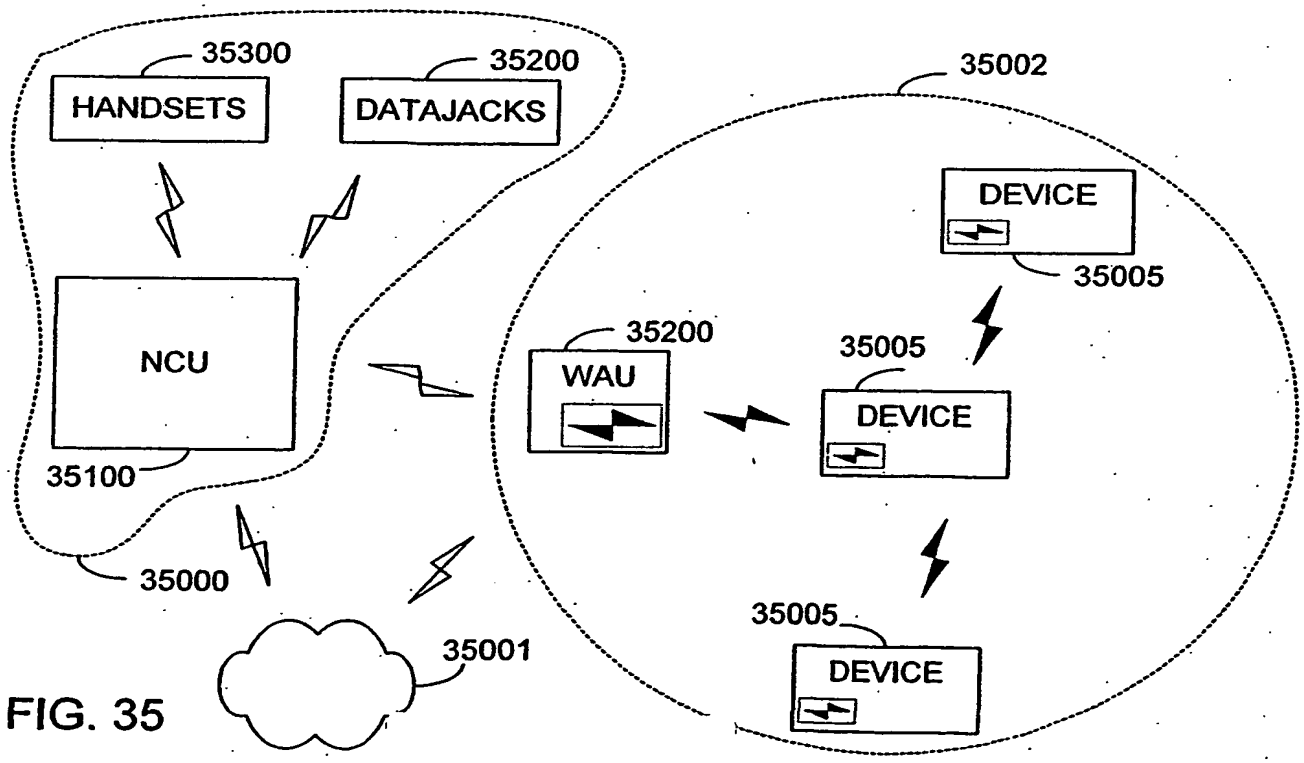

35300
HANDSETS
35200
DATAJACKS
NCU
35100
35000
35001
35002
DEVICE
35005
35200
WAU
35005
DEVICE
35005
DEVICE

FIG. 35

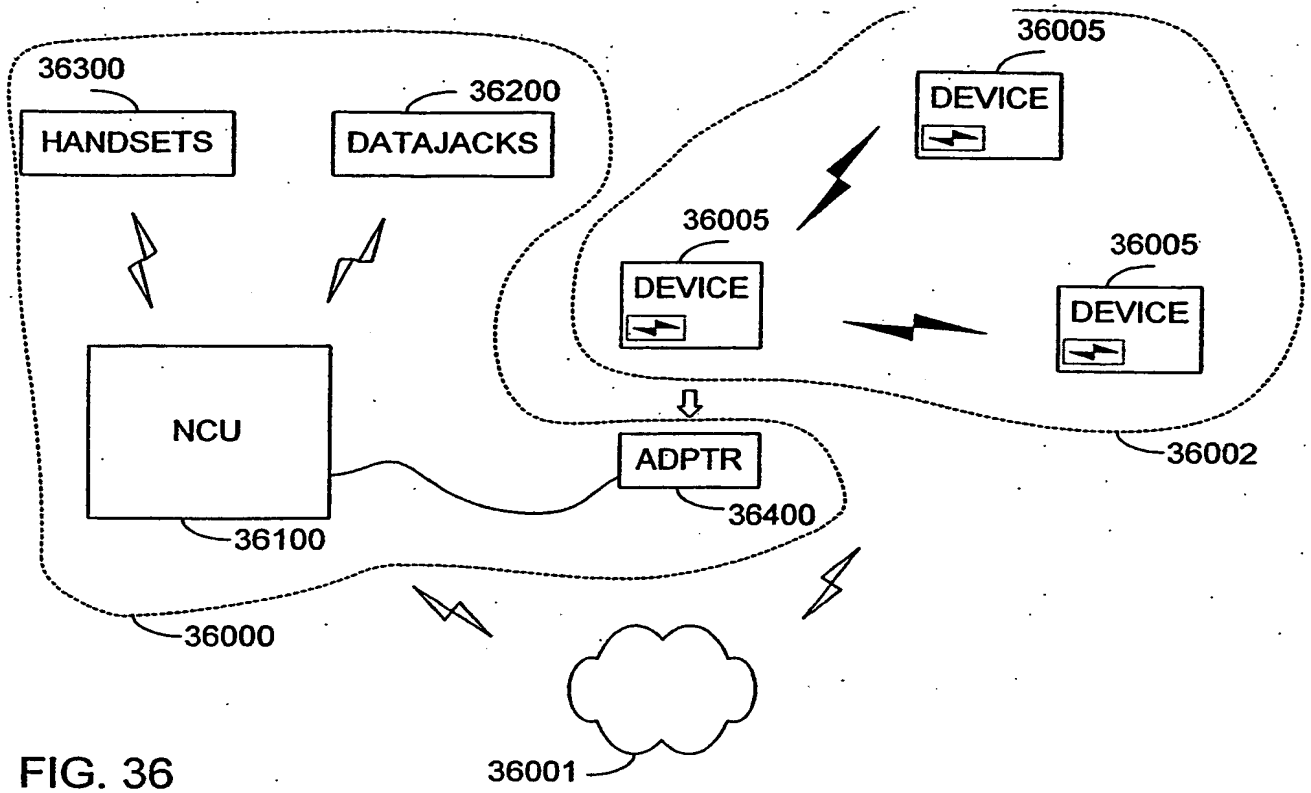


FIG. 36

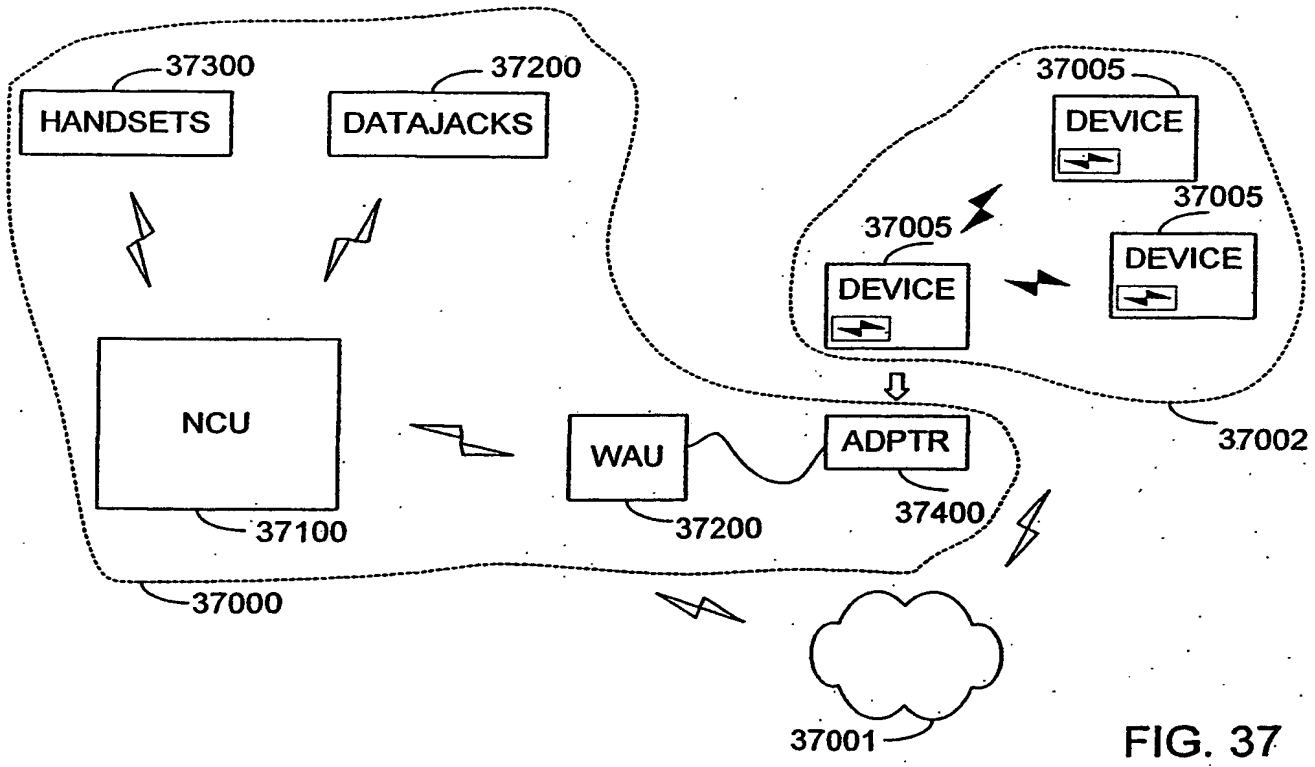


FIG. 37

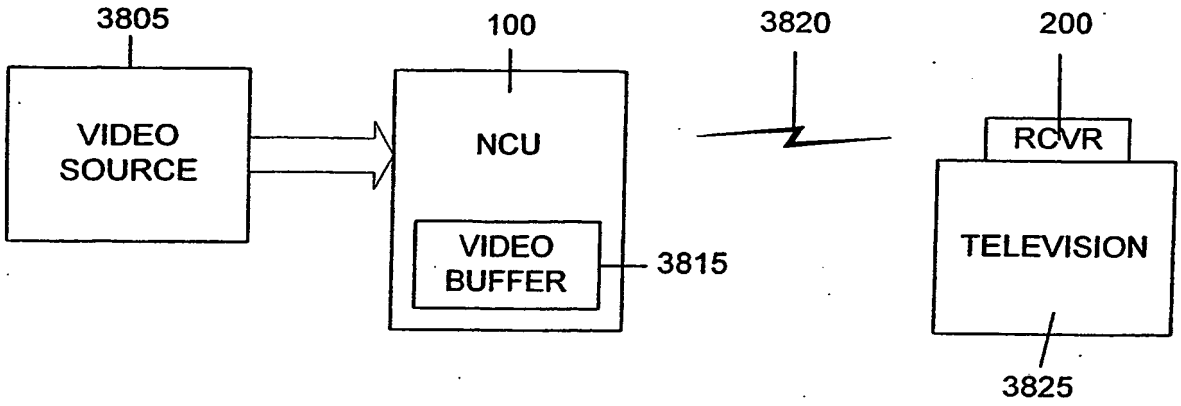


FIG. 38A

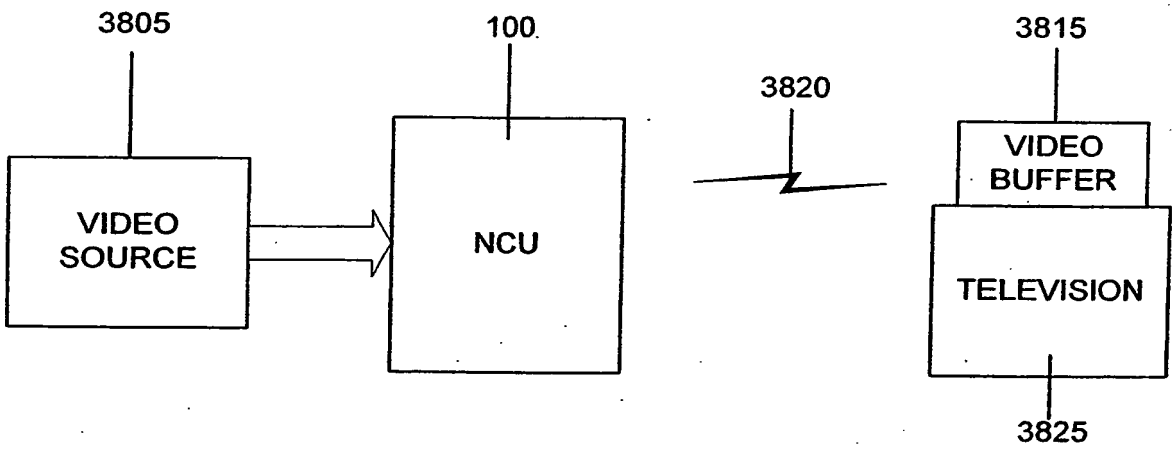


FIG. 38B

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(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
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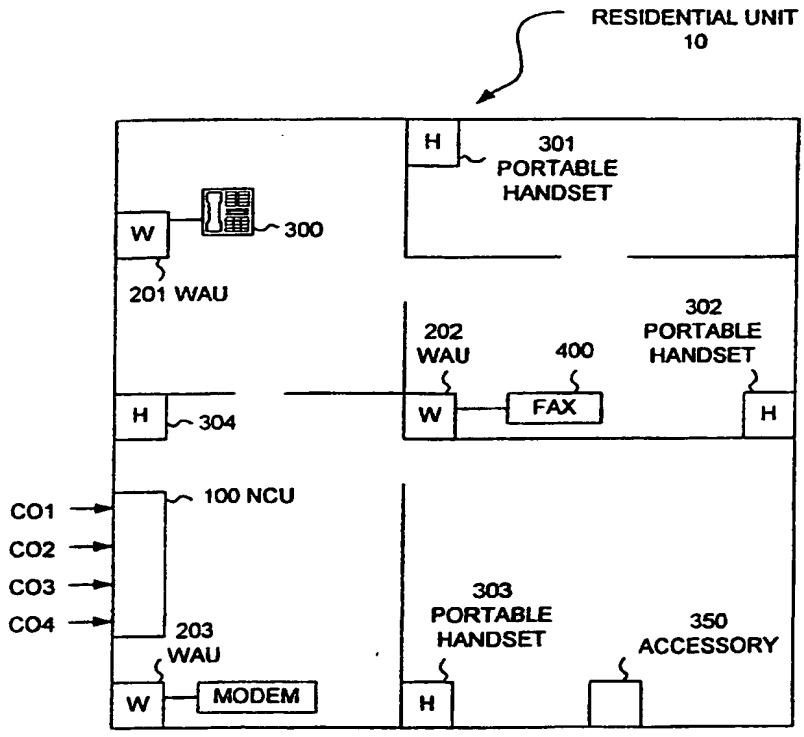
[Continued on next page]

(54) Title: WIRELESS COMMUNICATIONS GATEWAY FOR A HOME OR SMALL OFFICE



(57) Abstract: Systems for connectin telecommunications infrastrustures lines to telephones, handsets, computers, telecopy machines and other end user interfaces or consumer electronis devices in a residence or business. Systems according to the present invention inclue network control units which form the center of a star topology and which communicate via RF link with wireless access units and handsets. Wireless access units feature and interface, such as, for example, a standard telephone jack, for accommodating a telephone, a fax machine, a computer modem or other device. Numerous wireless applications are available through this system, including wireless home entry and security monitoring, internet connectivity, IP telephony, interfacing with PCS devices, and use with optical network units of telecommunications service providers. Such networks can be entirely mobile, connected to outside telecommunications networks via air interfaces such as cellular or PCS telephony interfaces. Wireless access units also allow vehicles to form part of such systems, so that various forms of information may be communicated between vehicles and residences or businesses. Control functionality for such systems can include intelligence of the sort found in telecommunications network elements and devices for providing advanced services to the user. Additional functionality can be included for supporting internet sessions.

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A. CLASSIFICATION OF SUBJECT MATTER
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B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
E	GB 2 361 849 A (SMITH GRAEME ROY) 31 October 2001 (2001-10-31) page 2, line 22 -page 3, line 29 page 4, line 12 -page 6, line 2 page 12, line 4 - line 39 page 13, line 28 -page 14, line 39 page 16, line 5 -page 18, line 2	1-51
A	EP 0 720 309 A (AT & T CORP) 3 July 1996 (1996-07-03) column 2, line 40 -column 3, line 31	1-51
A	EP 0 766 427 A (NOKIA MOBILE PHONES LTD) 2 April 1997 (1997-04-02) page 3, line 34 -page 4, line 16 page 6, line 15 - line 36	1-51

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Lõpez Pérez M-C.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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